

# Nutrition & Dietetics

interprofessional,  
interdisciplinary and  
intersectoral  
dietetic  
practice



# Nutrition & Dietetics

Journal of the Dietitians Association of Australia

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## EDITORIAL

# Inter-professional, interdisciplinary and inter-sectoral dietetic practice

Dietetics operates within a web of connections formed by the context in which practice occurs. In health-care settings, the focus is on the patient, and collaborative practice is essential. *Inter-professional* practice occurs where health-care teams work together with the patient to solve complex problems, determining treatment decisions and best ways forward. In clinical and other settings, working with the best evidence requires an integration of practice with scientific research, but this research can, and needs to, come from a number of disciplines. Scientific disciplines maintain the standards and assure rigour for knowledge generation, but an *interdisciplinary* approach is needed to bring forward the breadth of available knowledge for translation to practice. From the laboratory bench to the community and beyond, nutrition science itself reflects a range of disciplinary expertise. Finally, protecting health involves more than translating health sciences to practice; it also requires advocacy beyond the health sector. This pushes practice to *inter-sectoral* domains. In this light, WHO recognises that, for effective and sustainable action on health, there is a need to address the social determinants of health and equity issues.<sup>1</sup> These considerations add significantly to the scope of research in Dietetic practice while maintaining a sense of how it all fits together.

This first issue of the journal for 2019 explores the three concepts of inter-professional, interdisciplinary and inter-sectoral Dietetic practice. The array of papers in this issue exemplifies how Dietetic practice, and the associated research, is aligned to these concepts. Both practice and research have come a long way since the inception of the journal 75 years ago, and it is worth taking a moment to reflect on that history.

The journal began in 1944 with the Australian Institute of Anatomy publication, *Food and Nutrition Notes and Reviews*.<sup>2</sup> It was later transferred to the Commonwealth Department of Health and became known as the *Journal of Food and Nutrition*, where in 1979, the distinguished dietitian and head of the Nutrition Section, Dr. Ruth English AO, became Editor. The early connections with the academy and government reflect the underpinnings of Dietetics practice in the scientific disciplines and in service to public health.

The journal was subsequently transferred from the Commonwealth Department of Health to the Dietitians Association of Australia and, in 1989, became the *Australian Journal of Nutrition and Dietetics* and, in 2002, *Nutrition & Dietetics*. All three titles of the journal are catalogued in the

US National Library of Medicine (NLM),<sup>3</sup> with the Mesh term Dietetics\* latterly added. Dietetics involves the application of scientific knowledge to support the health of individuals and populations. At the heart of Dietetics is assuring and advocating for the delivery of nutrients in combinations of foods based on evidence from a body of sound science. Eating food, however, is a part of everyday life, and foods are made available through systems and processes reflecting societies and their use of the environment. Thus, an awareness of context is essential in Dietetics practice.

After much hard work by the profession, *Nutrition & Dietetics* is now indexed by Medline, Pub Med and Index Medicus, broadening the reach to many scientific disciplines and health professions. Publishing our research exposes the inherent expertise of authors as well as the range of methodologies used. Indeed, the journal's Table of Contents now demonstrates an array of research designs and methods used to provide the scientific underpinnings for practice. With a focus on inter-professional, interdisciplinary and inter-sectoral practice, this issue of the journal presents worthwhile examples of the range of methodologies applied.

Under 'Health Services Research', the need for *inter-professional practice* is well emphasised in delivering health care related to home enteral nutrition services,<sup>4</sup> advancing practice in gastronomy management<sup>5</sup> and considering the role of nutrition assistants in conducting head and neck cancer (HNC) clinics.<sup>6</sup> Role delineation is one of the key aspects emerging from this research. Publishing the findings helps to communicate and consolidate the evolving role of Dietetics in health-care services.

Publication also enables a critical mass of research to be built up. For example, in another study of HNC clinics in Australia and the USA, factors influencing the role of the dietitian were identified as dietetic autonomy, the scientific evidence for protocols and collaboration with medical and nursing staff.<sup>7</sup> In this context, qualitative interviews/focus groups, surveys and program evaluation are common research methods, providing evidence to support improvements as well as building theoretical frameworks for practice. There is a need for more of this research. A 2017 Cochrane review argued that, although poor inter-professional health care can produce adverse outcomes, there is insufficient evidence on effects from interventions. This is a developing field, with studies needing rigorous mixed methods and longer-term follow up.<sup>8,9</sup>

*Interdisciplinary practice* is particularly evident in research as it reflects the knowledge base and the technical skill

required to build that knowledge through scientific methods. By its nature, dietary assessment methodology is a central tenet of Dietetics, and developments are often led by Dietitian-researchers. The development of the ASA24 Australia is a good example, linking researchers in Australia and the USA.<sup>10,11</sup> Dietary assessment is prominent in 'Nutritional Epidemiology' and clinical trials, where it contributes significantly to study design (see in this issue Matsuo *et al.*,<sup>12</sup> Senevirathne *et al.*,<sup>13</sup> Truby *et al.*<sup>14</sup> and Rozendaal *et al.*<sup>15</sup>). Of course, this research has many facets, meaning dietitians work with other disciplines in these studies, particularly from medicine, the basic sciences and biostatistics. As epidemiological research often provides the evidence for practice, Dietetic researchers need to have strong commitment to interdisciplinary research. The same applies to research relating to food and effects of food consumption (e.g. see Easton *et al.*<sup>16</sup>), relevant biomarkers and standards of health (in this issue, see Ash *et al.*<sup>17</sup>) and educational research (in this issue, see Morgan *et al.*<sup>18</sup> and Kittisakmontri *et al.*<sup>19</sup>).

*Inter-sectoral practice* moves beyond health services and considers the social aspects of food consumption. Research in this area often applies qualitative and mixed methods as well as 'Survey Research' to address problems associated with influences on health behaviour. For example, in this issue of the journal, Kittisakmontri *et al.* report on the attitudes, knowledge and practices within urban families in Northern Thailand on complementary feeding of infants.<sup>20</sup> From a food service perspective, Williams provides a historical commentary on Australian cookbooks outlining the advice and recipes in the disabled and convalescent context.<sup>21</sup> The letter to the Editor takes a public health advocacy position in relation to Australia's Health Star Rating System.<sup>22</sup> This area of practice (and research) has a broad focus, albeit linked back to nutrition science and health priorities for health protection.

The categories of inter-professional, interdisciplinary and inter-sectoral practice are helpful in mapping out the scope for informative research, but like most categories, they overlap. The Primary Health Centre (PHC) setting, for example, provides a new horizon for research in inter-professional practice, particularly as multiple professions provide expertise in preventive health care.<sup>23</sup> An inter-professional PHC service, however, requires a full appreciation of the discipline expertise, but the PHC setting itself can also be considered from an inter-sectoral perspective given the different social groups it serves. In this light, a recent systematic review on PHC for migrants and asylum seekers shows there are challenges and facilitators for health professions.<sup>23</sup>

Publishing practice-oriented research not only confirms the knowledge contribution of nutrition-related disciplines, it also exposes the methodological expertise available to Dietetics. In this 75th anniversary year of the journal *Nutrition & Dietetics*, we celebrate where we have come from and look forward to our ongoing efforts to build expertise, across professions, across disciplines and across sectors in support of better nutritional health for all.

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## Conflict of interest

Linda Tapsell is the Editor in Chief for *Nutrition & Dietetics*.

## Authorship

Linda Tapsell was the sole author of this manuscript.

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## ORIGINAL RESEARCH

## Evaluation of home enteral nutrition services at public hospitals in New South Wales, Australia

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**Abstract**

**Aim:** There is currently limited information regarding the home enteral nutrition population and its service practice at the state and national levels. The aim of this study is to report on patient numbers and demographics of the home enteral nutrition population in New South Wales, and to evaluate the implementation of home enteral nutrition services in public hospitals in the state.

**Methods:** A cross-sectional study was conducted using two online questionnaires, which were completed by the dietitian overseeing home enteral nutrition at each participating hospital.

**Results:** The home enteral nutrition population of participating hospitals was approximately 7600, with 81% oral nutrition support patients and 19% tube-fed patients. Mean compliance score to the home enteral nutrition implementation checklist was 54.1% ( $\pm 20.7\%$ ), with a range of 14.3% to 98.2%. Hospitals with a home enteral nutrition dietitian/coordinator scored a higher rate of compliance with the implementation checklist compared with hospitals without one (79.6% ( $\pm 15.6\%$ ) vs 47.6% ( $\pm 2.4\%$ );  $P < 0.001$ ). The key service improvements suggested by dietitians included increased funding towards a home enteral nutrition dietitian/coordinator (67.8%); improved resources to provide outpatient reviews, home visits and multidisciplinary service model (54.2%); improved database management and a more efficient registration process (52.5%).

**Conclusions:** Home enteral nutrition services continue to be inconsistent across New South Wales. Funding and resource limitations were identified as the major barriers to addressing gaps in service provision.

**Key words:** enteral nutrition, health services, nutrition support.

**Introduction**

Home enteral nutrition (HEN) is a service provided to clients within a home setting. It offers dietary products specifically designed to help improve or maintain nutritional status,<sup>1</sup> and is inclusive of oral nutrition support (ONS) and tube feeding (TF).<sup>2</sup> HEN is available to clients to assist in the maintenance of adequate nutritional status, which is necessary for growth, wound healing and immune function.<sup>3</sup>

Despite an absence of recent New South Wales (NSW) data, a continued increase in HEN patient numbers is predicted due to several factors including, technological

development in healthcare, greater recognition of both nutrition's role in improving health outcomes and the benefits of home-based care on quality of life, and the higher demand for healthcare due to an ageing population.<sup>4,5</sup> Approximately, two-thirds of HEN patients have been reported to require ONS and the remaining are on TF.<sup>4</sup> Most patients reside in metropolitan NSW, with approximately 25% living in rural and regional areas.<sup>4</sup> Common population groups utilising HEN include frail elderly and patients diagnosed with cancer, non-malignant respiratory disease or neurological disorders.<sup>5</sup>

With the expanding nature of HEN services, many studies have reported beneficial effects of the therapy. Reported advantages of HEN include decreased risk of malnutrition-related complications, reductions in hospital length of stay and associated healthcare expenses.<sup>3,6,7</sup> However, due to the lack of a standardised statewide or national framework for HEN, inconsistencies exist within the implementation of HEN services, which consequently has resulted in inconsistent service delivery and unknown number of HEN patients.<sup>1,2,8,9</sup> Inequity in level of patient follow up and financial assistance (e.g. co-payments) can create financial disadvantage to patients based on their place of residence.<sup>1,2</sup>

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In response to the absence of a national HEN guideline or framework, the NSW Agency for Clinical Innovation (ACI) has developed HEN service guidelines based on the best available evidence.<sup>10</sup> The guidelines cover nutrition support access, as well as the delivery, implementation, monitoring and review of HEN, and aim to help improve the current standard of service of HEN in NSW and establish a more equitable service for patients.<sup>10</sup> As Australia also lacks a national HEN registry, the Non-admitted Patient Self-administered Services at Home (NAPSASH) data collection tool has been implemented in NSW for the mandatory reporting of TF patient numbers living at home in NSW and to record the number of hospital admissions of these patients.<sup>11</sup> Data collected indicates there was an average of 1410 patients per month on TF at home (range: 1043–1636) across 16 local health districts (LHDs) and/or specialty health networks (SHNs) from October 2015 to June 2016.<sup>11</sup>

This investigation follows from a study conducted in 2014, by the same authors, which assessed HEN services at 13 principal referral hospitals in NSW against the ACI HEN service guidelines.<sup>2</sup> As the 2014 study focused on principal referral hospitals, the findings may not accurately reflect the HEN service across the state, and further investigation is required.

Therefore, the aims of this study are to report on patient numbers and demographics of the HEN population, and to investigate and evaluate the implementation of HEN services at public hospitals in NSW.

## Methods

This cross-sectional study included public hospitals in NSW that offer HEN services. Public hospitals were identified from the Ministry of Health website.<sup>12</sup> Department of Nutrition and Dietetics managers were contacted to confirm if their facility offered a HEN service and for consent for study participation.

Two self-administered online questionnaires utilising the Survey Monkey platform (SurveyMonkey Inc., San Mateo, CA, www.surveymonkey.com) were used to collect HEN patient data from recruited hospitals from 1 September 2016 to 31 December 2016. The first questionnaire consisted of 33 questions covering three domains—patient numbers, clinical resources and patient monitoring. The second questionnaire consisted of 28 questions and was adapted from the ACI HEN service implementation checklist.<sup>10</sup> Compliance scores were quantified as a percentage out of 28 items to indicate the level of compliance with the guidelines, where one point was awarded for every 'in place' and half a point for every 'in progress' achievement.

From the hospitals identified as providing a HEN service, the dietitian mainly involved in HEN was contacted via phone or email and invited to participate in the study. Participation was voluntary and dietitians could withdraw at any time. Following collection of consent forms, participants were emailed the two survey links. Participating dietitians were requested to complete the surveys within

1–2 weeks. Dietitians overseeing HEN services at multiple hospitals were asked to complete the surveys for each facility. Reminder emails were sent at 1 and 2 weeks after the delivery of the survey links to dietitians who had not completed the surveys within the requested period.

For confidentiality, each participating hospital was randomly assigned a hospital identification number. Data collected were reported as descriptive statistics and analysed by *t*-tests and Fisher's exact tests using IBM Statistical Package for Social Sciences (SPSS, IBM Corporation, Armonk, NY) version 21. A *P*-value of <0.05 was required for statistical significance.

The study protocol was approved by the Western Sydney Local Health District Human Research Ethics Committee. This study was prepared based on strengthening the reporting of observational studies in epidemiology (STROBE) statement for cross-sectional studies.<sup>13</sup>

## Results

Ninety-five hospitals in NSW were identified to have a HEN service, and of these, dietitians from 59 hospitals participated in the study (response rate of 62.1%). Each LHD and SHN in NSW was represented by at least one hospital, and 29 out of 59 (49.2%) participating hospitals were located in NSW rural LHD's. Approximately, 7600 HEN patients were reported (Table 1), with 81% requiring ONS and 19% requiring TF.

Only 12 hospitals (20.3%) reported having a HEN dietitian/coordinator, with full time equivalents (FTEs) ranging from 0.1 to 2.0. One-third of hospitals with a HEN dietitian/coordinator (*n* = 4) were considered a larger hospital ( $\geq 500$  beds). Roles and responsibilities of the HEN dietitian/coordinator included reporting to management about the HEN service (100%, *n* = 12), the review of HEN patients (92%, *n* = 11), maintaining a database of HEN patients (83%, *n* = 10), and developing and updating a HEN policy (83%, *n* = 10).

Approximately two-thirds of hospitals (66.1%) reported having a HEN patient monitoring system (e.g. database) for TF HEN, while only 43.1% of hospitals reported a monitoring system in place for oral HEN. Hospitals with a HEN dietitian/coordinator were more likely to have a local system in place to record and monitor the review schedule of all HEN patients (91.7% vs 17.0%, *P* < 0.001).

Less than half the hospitals (40.7%, *n* = 24) reported having a hospital or LHD-specific HEN Policy in place, including 34.5% (*n* = 10) of rural hospitals and 46.7% of metropolitan hospitals (*n* = 14). Hospitals with a HEN dietitian/coordinator were more likely to have a local policy in place when compared to hospitals without a HEN dietitian/coordinator, outlining: the scope and provision of HEN services (83.3% vs 8.5%, *P* < 0.001), appropriate patient selection for HEN (83.3% vs 19.1%, *P* < 0.001), appropriate selection of HEN delivery methods (83.3% vs 34.0%, *P* = 0.013), parameters to be monitored (83.3% vs 8.5%, *P* < 0.001), and appropriate HEN termination (66.7% vs 6.4%, *P* < 0.001).

**Table 1** Home enteral nutrition (HEN) patient numbers at public hospitals in NSW

Hospital	Number of beds	Patients >18 years (ONS)	Patients >18 years (TF)	Patients >18 years (both)	Patients <18 years (ONS)	Patients <18 years (TF)	Patients <18 years (both)	Total HEN Patients <sup>(a)</sup>
H1	100–299	>40 <sup>(b)</sup>	>30 <sup>(b)</sup>	ND	ND	10–20 <sup>(b)</sup>	ND	>80–90
H2	100–299	130 <sup>(b)</sup>	5 <sup>(b)</sup>	0	1 <sup>(b)</sup>	0	0	136
H3	300–499	118	15	5	12	1	1	152
H4	<100	ND	3	ND	ND	ND	ND	3
H5	<100	100 <sup>(b)</sup>	10 <sup>(b)</sup>	0	0	1	0	111
H6	<100	10	0	0	0	0	0	10
H7	300–499	113	11	0	7	0	0	131
H8	<100	35	1	0	0	6	0	42
H9	<100	27	2	1	1	1	0	32
H10	<100	30	1	1	2	0	0	34
H11	<100	40 <sup>(b)</sup>	10–15 <sup>(b)</sup>	1–2 <sup>(b)</sup>	0	0	0	51–57
H12	100–299	80	40	10	0	0	0	130
H13	300–499	ND	40	13	ND	30	16	99
H14	<100	6 <sup>(b)</sup>	0	0	0	0	0	6
H15	<100	13 <sup>(b)</sup>	0	1	5 <sup>(b)</sup>	0	0	19
H16	100–299	70 <sup>(b)</sup>	8	12	15 <sup>(b)</sup>	8	3	116
H17	300–499	402	12	2	0	0	0	416
H18	100–299	160 <sup>(b)</sup>	45 <sup>(b)</sup>	0	3 <sup>(b)</sup>	6	0	214
H19	100–299	280	45	6	0	0	0	331
H20	<100	15 <sup>(b)</sup>	3	1	3 <sup>(b)</sup>	0	0	22
H21	300–499	ND	43	8	40 <sup>(b)</sup>	31	0	122
H22	<100	0	0	0	0	4	0	4
H23	100–299	240 <sup>(b)</sup>	8 <sup>(b)</sup>	0	10 <sup>(b)</sup>	1	0	259
H24	<100	0	0	0	0	0	0	0
H25	<100	2	1	ND	0	0	ND	3
H26	100–299	200 <sup>(b)</sup>	8	0	9	1	0	218
H27	100–299	20–50 <sup>(b)</sup>	5	0	4	0	0	29–59
H28	<100	3 <sup>(b)</sup>	0	0	0	0	0	3
H29	≥700	200 <sup>(b)</sup>	61	0	60 <sup>(b)</sup>	26	0	347
H30	<100	10	2	0	0	0	0	12
H31	100–299	ND	ND	ND	15 <sup>(b)</sup>	10 <sup>(b)</sup>	1	26
H32	<100	70 <sup>(b)</sup>	10	2	4 <sup>(b)</sup>	3	2	91
H33	300–499	300 <sup>(b)</sup>	40 <sup>(b)</sup>	3 <sup>(b)</sup>	17 <sup>(b)</sup>	12 <sup>(b)</sup>	5 <sup>(b)</sup>	377
H34	300–499	260 <sup>(b)</sup>	13	2 <sup>(b)</sup>	10 <sup>(b)</sup>	0	0	285
H35	100–299	40 <sup>(b)</sup>	9	0 <sup>(b)</sup>	10 <sup>(b)</sup>	4	0 <sup>(b)</sup>	63
H36	<100	30 <sup>(b)</sup>	2	0	3 <sup>(b)</sup>	0	0	35
H37	<100	2	1	0	0	0	0	3
H38	<100	ND	25	6	0	3	0	34
H39	100–299	80–110 <sup>(b)</sup>	10 <sup>(b)</sup>	2–3 <sup>(b)</sup>	10–15 <sup>(b)</sup>	10–15 <sup>(b)</sup>	2 <sup>(b)</sup>	114–155
H40	<100	40 <sup>(b)</sup>	15 <sup>(b)</sup>	5 <sup>(b)</sup>	5 <sup>(b)</sup>	5 <sup>(b)</sup>	0	70
H41	<100	2–3	0	0	0	0	0	2–3
H42	100–299	10 <sup>(b)</sup>	0	0	0	0	0	10
H43	500–699	ND	20	ND	ND	15	ND	35
H44	≥700	ND	18	8	ND	0	0	26
H45	<100	25 <sup>(b)</sup>	3	1	0	0	0	29
H46	100–299	500 <sup>(b)</sup>	1	0	0	0	0	501
H47	100–299	ND	ND	ND	ND	ND	ND	0
H48	≥700	354 <sup>(b)</sup>	39	11	34	5 <sup>(b)</sup>	0	443
H49	100–299	ND	4	0	ND	0	0	4
H50	<100	87	2	5	0	0	0	94
H51	300–499	150 <sup>(b)</sup>	5	0	0	0	0	155
H52	300–499	65–75	8	3	4	0	0	80–90
H53	100–299	100	10	0	20	10	0	140
H54	300–499	0	0	0	470 <sup>(b)</sup>	285 <sup>(b)</sup>	20 <sup>(b)</sup>	775

Table 1 Continued

Hospital	Number of beds	Patients >18 years (ONS)	Patients >18 years (TF)	Patients >18 years (both)	Patients <18 years (ONS)	Patients <18 years (TF)	Patients <18 years (both)	Total HEN Patients <sup>(a)</sup>
H55	100–299	250 <sup>(b)</sup>	15 <sup>(b)</sup>	5 <sup>(b)</sup>	5 <sup>(b)</sup>	1 <sup>(b)</sup>	1 <sup>(b)</sup>	277
H56	<100	100 <sup>(b)</sup>	0	0	0	0	0	100
H57	<100	20	1	0	0	0	0	21
H58	≥700	501	97	4	19	0	0	621
H59	500–699	ND	15	ND	ND	5	ND	20
Total <sup>(a)</sup>	N/A	5330–5401	772–777	118–120	793–803	494–509	51	7563–7661

N/A, not applicable; ND, no data; both, oral nutrition support (ONS) and tube feeding (TF).

<sup>(a)</sup> Total numbers may not be precise due to estimates and missing data.

<sup>(b)</sup> Estimated number of HEN patients provided by hospital.

Only three hospitals (5.1%) reported offering financial assistance to HEN patients in the form of a co-payment by the Nutrition & Dietetics Department or LHD. One hospital reported offering a 10% discount to patients with Head & Neck Cancer or Oesophageal Cancer undergoing treatment at the hospital (i.e. radiation therapy and/or chemotherapy), and this discount was increased to 50% for Commonwealth issued Health Care Card holders.

Figure 1 displays information regarding the frequency of review for new and existing HEN patients. An outpatient clinic was available to review ONS and TF HEN patients in 78.0% and 84.2% of hospitals, respectively, however, only 10.5% of hospitals reported access to a multidisciplinary team to manage and review HEN patients. Home visits were available to review ONS and TF HEN patients in 27.1% and 38.6% of hospitals, respectively.

The mean scores for the current level of achievement of the ACI HEN service implementation checklist are presented in Table 2. The mean compliance score was 54.1% ( $\pm 20.7\%$ ), with a range of 14.3% to 98.2% (Figure 2). An independent *t*-test showed that mean ACI HEN implementation checklist score (%) was significantly higher in hospitals with a HEN dietitian/coordinator than hospitals without (79.6% ( $\pm 15.6\%$ ) vs 47.6% ( $\pm 2.4\%$ );  $P < 0.001$ ).

The key service improvements suggested by dietitians included increased funding towards a HEN dietitian/coordinator (67.8%), improved resources to provide outpatient reviews and home visits, including a multidisciplinary team (54.2%), implementation and/or improvements of database and more efficient registration process (52.5%) and strategies to reduce the financial burden on patients requiring HEN (16.9%).

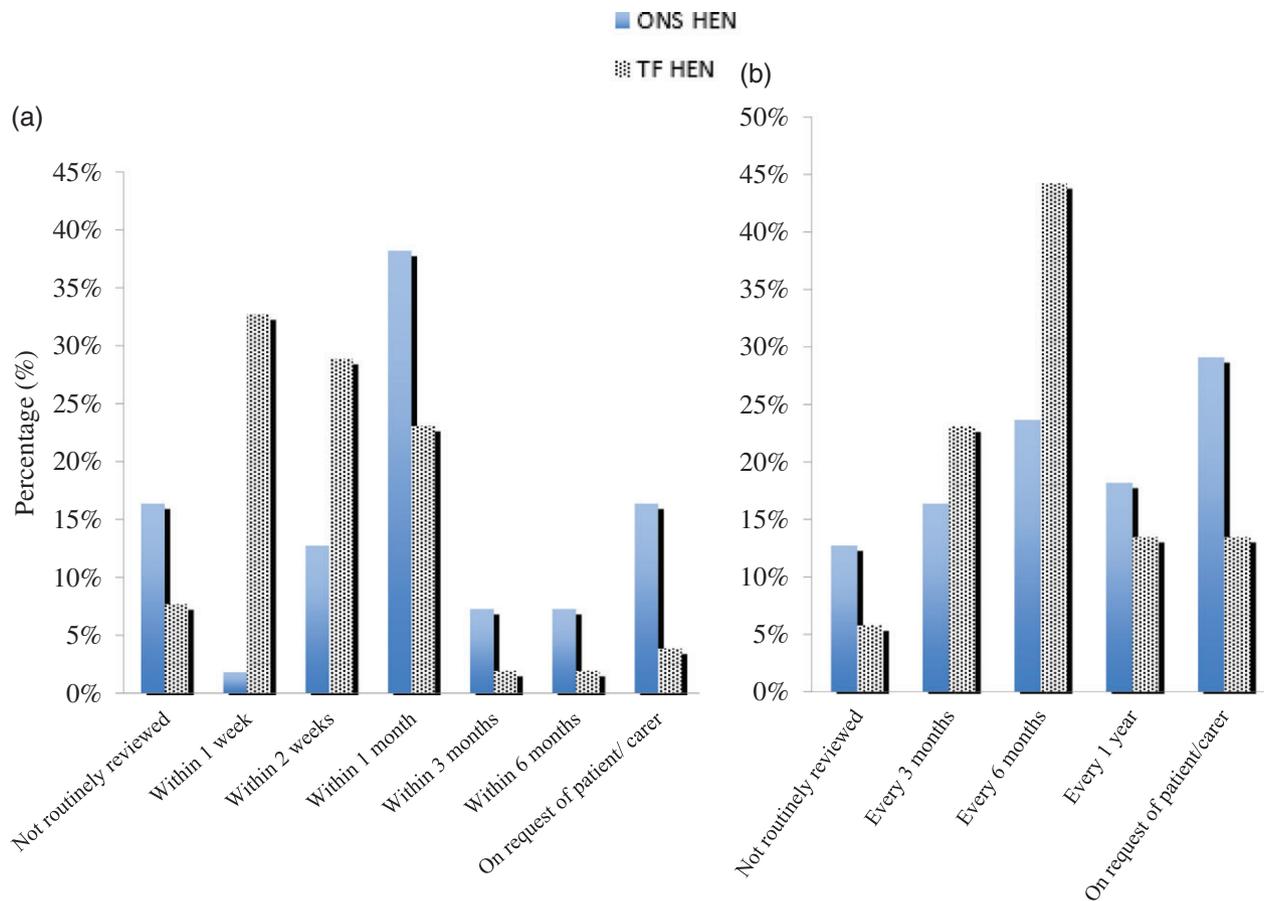
## Discussion

This study expanded on previous research investigating HEN services in NSW in 2014,<sup>2</sup> and invited all public hospitals with a HEN service at a statewide level to participate, in order to gain more detail about HEN patient numbers and service delivery in NSW. Participating hospitals had an estimated HEN population of 7600. Considering likely underestimation and missing HEN patients from non-participating hospitals, the population is comparable to the

estimated 8000–10 000 reported in 2007.<sup>4</sup> This result aligns with the 2014 study, which suggested that the growth rate in NSW had stabilised despite predictions of continued growth.<sup>2,4,5</sup> From the data, HEN patients requiring ONS were approximately four times greater (81%) than those requiring TF (19%), and suggests a growing demand for ONS when compared with 76% of HEN patients requiring ONS reported in 2014<sup>2</sup> and 68% of adult HEN patients requiring ONS in 2007.<sup>4</sup>

Precise population numbers were unable to be reported as not all facilities had HEN monitoring systems in place. Patient monitoring systems are important to ensure appropriate patient follow up and to produce service reports. Aware of this significance, implementation and/or improvements to a patient monitoring database was among the top service improvements suggested by dietitians. In addition, the majority of hospitals (79.7%,  $n = 47$ ) did not have a HEN dietitian/coordinator, thus at many facilities HEN responsibilities were integrated into clinical workloads, with patients monitored at the discretion of their respective dietitian. A lack of HEN dietitian/coordinators and multidisciplinary teams are likely contributing factors to inconsistent service delivery to patients. Both these resources help to ensure consistent quality of care including the provision of reliable information and support, efficient referrals to other health professionals, and regular patient follow up.<sup>14</sup> Evidence of a HEN dietitian/coordinator improving the HEN service was shown through significant differences in overall ACI HEN implementation checklist score ( $P < 0.001$ ). This is likely because the role ensures HEN responsibilities are accounted for by allocating them to specific individuals.

From this current study, only 24 participating hospitals had a hospital or LHD-specific HEN policy, which highlights a possible contributor towards inconsistencies between HEN services across the state. Studies conducted in Europe have also reported similar inconsistencies in the implementation of specific HEN legislation and guidelines.<sup>8,9</sup> Within the European countries where legislations exist, there are variations regarding the definition of HEN as well, which thereby affect the service available to people from different countries. Thus, service gaps and discrepancies in service provision exist within and between these countries.<sup>8</sup> From the results of this current study, it was



**Figure 1** Monitoring and review of home enteral nutrition (HEN) patients at public hospitals in NSW. (a) Compares the time of initial review for new HEN patients at participating hospitals, while (b) compares the frequency of review for long-term HEN patients. Responses are expressed as a percentage of total number of responses to the corresponding question in the first questionnaire. The dotted columns indicate patients on oral nutrition support (ONS) and the solid blue columns indicate tube feeding (TF) HEN patients.

significantly more likely that hospitals with HEN dietitians/coordinators had key HEN policies in place ( $P < 0.05$ ). Thus, emphasising the importance of this role in hospitals to facilitate adequate service delivery, and also highlighting the need for a national framework to guide the delivery of a uniform and equitable service.

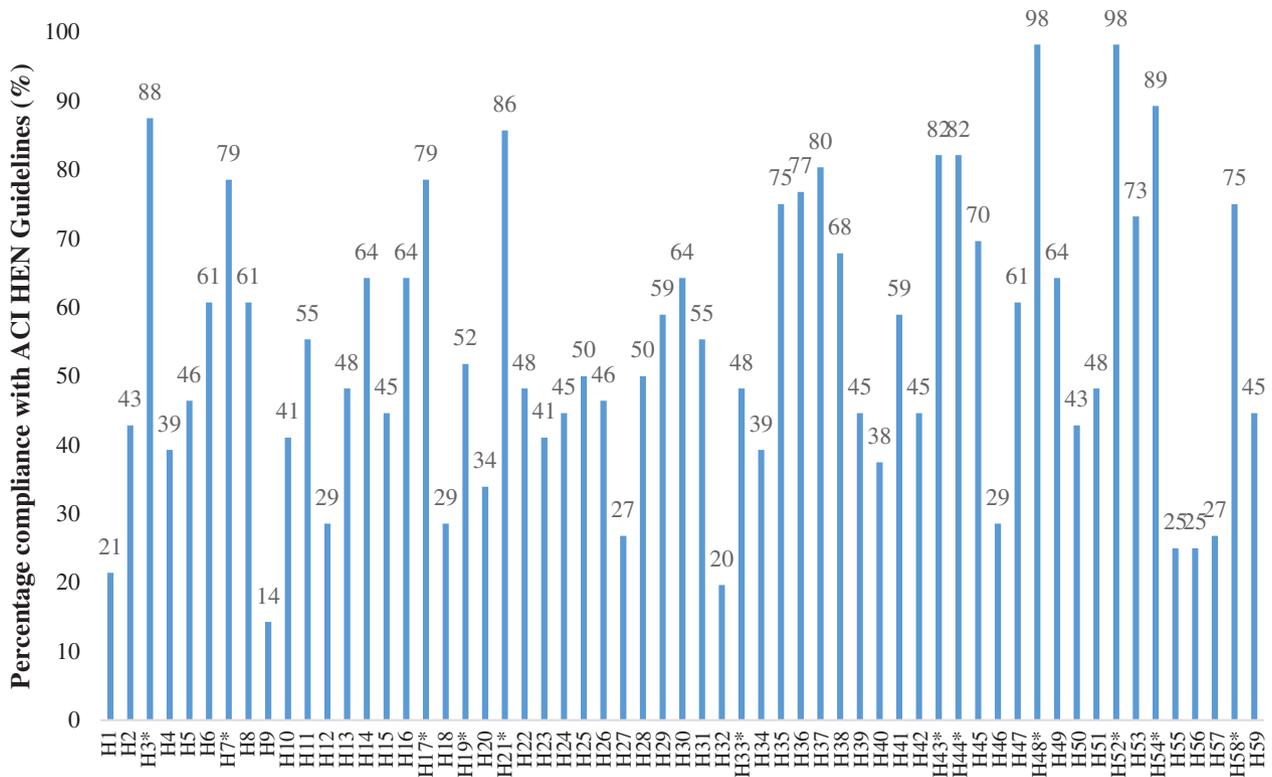
In conjunction with funding support for hospitals, participating dietitians also suggested implementing strategies to reduce the financial burden on HEN patients, such as co-payments. The inconsistencies in the availability of co-payments to purchase HEN products across different states and territories in Australia have been described previously.<sup>1,2,4,15</sup> The National Disability Insurance Scheme (NDIS) provides scope for funding of HEN products and equipment to eligible patient groups.<sup>16</sup> Internationally, New Zealand, some European countries including the UK, and the US offer full or partial subsidies for eligible residents, with funding typically covered through national budgets.<sup>4,17</sup> Therefore, a national funding scheme allowing patients access to consistent and more affordable formulas and equipment would reduce service inequity across the

country. In 2007, the monthly expense ranges for HEN in NSW were \$60–\$174 for ONS patients and \$110–\$932 for TF patients.<sup>4</sup> As these figures can accumulate to a substantial sum, funding would also help to reduce the burden on families.<sup>1,7,18</sup> Although NSW does not offer co-payments, three participating hospitals reported providing co-payments to patients at the hospital's discretion.

A strength of this study was the inclusion of public hospitals statewide provided a more comprehensive report on HEN services in NSW, than had previously been conducted. Comparing ACI HEN implementation checklist scores achieved against the 2014 study,<sup>2</sup> the range of scores was larger (14%–98% compared to 29%–86% respectively), and the average score was lower (54% compared to 61%, respectively). The difference was likely due to more participating hospitals, particularly the smaller regional and rural facilities, which may have less resources to facilitate a HEN service. Additionally, expanding the study to more hospitals identified that a smaller proportion of hospitals had a HEN dietitian/coordinator (20%,  $n = 12$ ) compared to what was previously reported in the principal referral hospitals in

**Table 2** Scores of NSW public hospitals against NSW health agency for clinical innovation home enteral nutrition (HEN) service guidelines<sup>10</sup> (n = 59)

Section	Measure	Current level of achievement (%)			
		In place	In progress	Not in place	
Nutrition support health professionals	All HEN patients have access to nutrition support health professionals	Dietitian	85	8	7
		Nutrition support nurse	12	5	83
		Speech pathologist	56	8	36
		Medical practitioner	69	7	24
		The health professionals providing HEN care are: appropriately qualified; attend appropriate and regular training on HEN care; liaise with referring and other health professionals	69	7	24
		There is a coordinated HEN service and an expert lead	15	12	73
		The role of each health professional involved in HEN is defined and communicated to each member of the team	22	22	56
Selection and assessment	There are local policies or guidelines in place to ensure appropriate: patient selection for HEN; patient assessment	32	22	46	
Nutrition and support access	There are nutrition support health professionals who have appropriate expertise to: determine the appropriate nutrition support access route; insert, remove and replace HEN access devices	31	22	47	
	Standard techniques and protocols exist for the proper care and management of enteral access	44	29	27	
Delivery methods, selection of formula and timing of feeds	There are local policies or guidelines in place to ensure appropriate selection of: HEN delivery methods, formula, rate and timing	44	27	29	
Nutrition Care Plan	An appropriate nutrition care plan is developed for each HEN patient with input from patient/carers and all relevant health professionals	76	17	7	
	The patient or carer receives a copy of the nutrition care plan	81	9	10	
	The nutrition care plan is communicated to all nutrition-support health professionals and the patient's general practitioner	51	24	25	
Implementation	HEN patients/carers receive relevant training and education on nutrition support	71	22	7	
	Written education resources specific to the patients assessed needs and ability are provided to HEN patients/carers	71	24	5	
Monitor and review	A review schedule is planned for each HEN patient and communicated to the patient/carers	64	22	14	
	For tube fed HEN patients, an initial home visit is arranged within the first week after transfer home	19	14	67	
	For oral HEN patients, an initial review (telephone/clinic/home visit) is conducted within 2 weeks of transfer home	25	19	56	
	All HEN patients are reviewed by nutrition-support health professionals after the first 3 months of initial treatment, and then at no longer than 6 monthly intervals	39	19	42	
	There is a single point of contact for HEN patients	36	10	54	
	There are local policies or guidelines outlining the parameters to be monitored	24	20	56	
Transition feeding	There are systems in place to ensure appropriate assessment and nutritional adequacy for HEN patients who transit from tube feeding to oral diet	52	19	29	
Termination	The HEN service includes protocols on appropriate HEN termination	19	25	56	
Medical record	Medical records are appropriately maintained for all HEN patients	81	15	4	
Policies and procedures	The HEN service is guided by up-to-date local policies and procedures on the scope and provision of HEN services	25	31	44	
	There is a local system in place to record and monitor the review schedule of all HEN patients	32	22	46	
Quality assurance	The HEN service undertakes quality improvement activities and outcome measurement, including patient satisfaction	12	27	61	



**Figure 2** Total compliance scores of home enteral nutrition (HEN) services at public hospitals in NSW assessed against the ACI HEN service implementation checklist. Scores are displayed on the vertical axis and are expressed as a percentage out of a total maximum score of 28. The horizontal axis represents each participating hospital which have been de-identified using hospital codes. Hospitals with a HEN dietitian/coordinator are identified with an asterisk (\*).

2014 (69%, n = 9),<sup>2</sup> which may have impacted on the compliance scores.

A limitation of this study is that data is missing from 38% of NSW public hospitals who have a HEN service, despite many attempts to collect the data. This potential response bias may have led to more positive results, however a similar number of metropolitan and regional or rural hospitals participated. Furthermore, 34% of hospitals had no database for TF HEN patients and 57% had no database for oral HEN patients. Therefore, the participating dietitian was required to estimate HEN patient numbers when a patient monitoring system was not in place, which would affect the accuracy of reported patient numbers. Also, 80% did not have a HEN coordinator, whose usual duties are to maintain HEN patient databases. Finally, relying on self-report may produce more positive results due to respondents not wanting to report a poor service to the researchers. A positive aspect was that some hospitals were using this as an opportunity to review and improve their HEN services.

In future, continued research into HEN services and regular service audits will assist with improving the continuum of care and provide updated data regarding patient numbers. Investigations should extend to other states and territories to gather national data about HEN services.

Furthermore, prospective studies evaluating the effectiveness of HEN improving patient outcomes are needed to further strengthen the advocacy for increased funding and resources allocated to HEN.

The results of this study have reported on statewide HEN patient numbers, and in relation to statewide HEN service guideline implementation results are consistent with those previously reported.<sup>2</sup> HEN services in public hospitals in NSW continue to be inconsistent. Best practice guidelines are not firmly adhered to, and funding and resource limitations were identified as the key barriers to addressing gaps in service provision. The development of a centralised database for all HEN patients may greatly improve the service by allowing dietitians to monitor and review their patients appropriately. Increased number of HEN dietitian/coordinator positions would also enhance the service to assist facilities in meeting the service items recommended in the ACI HEN service guidelines, and hence provide a consistent, safe and equitable service.

### Conflict of interest

The authors declare no conflict of interest.

## Authorship

DT was involved in data collection, analysis of results and writing the draft manuscript. EKP was involved in development of the study design, analysis of results, and contributed to writing the manuscript. SSF was involved in development of the study design and contributed to writing the manuscript. NLH was involved in writing the manuscript. PT was involved in development of the study design and contributed to writing the manuscript. The authors would like to acknowledge the Dietetics and Nutrition Departments of public hospitals in NSW for their participation.

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## ORIGINAL RESEARCH

## Introducing novel advanced practice roles into the health workforce: Dietitians leading in gastrostomy management

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**Abstract**

**Aim:** The number of advanced practice roles in the Australian health-care system is growing alongside contemporary health-care reforms. The present study aimed to evaluate the impact of introducing novel advanced practice dietitian roles in gastrostomy tube (g-tube) management and develop a competency framework for progressing opportunities in dietetics practice and policy.

**Methods:** A questionnaire was distributed to service lead dietitians at six participating health-care networks at the completion of a dedicated advanced practice funding grant, and at 12-month follow up. Service changes (e.g. number of dietitians credentialed, service and adverse events, change in patient waiting times and staff satisfaction), enablers and barriers for the implementation of the novel roles (including pre-, during, and post-implementation), and clinical costing estimates to measure the financial impact on the health system were investigated. Participant feedback was also used to synthesise the development of an advanced scope of practice pathway to competency.

**Results:** Responses were received from all participating health-care networks. Five out of six sites successfully implemented an advanced practice role in g-tube management, with conservative health system savings estimated at \$185 000. Ten dietitians were credentialed, with a further seven trainees in progress. Over 200 service events were recorded, including those diverted from other health professionals. Enabling factors for successful introduction included strong executive and stakeholder support, resources provided by grant funding, and established credentialing governance committees. Barriers included recruitment and governance processes.

**Conclusions:** Opportunities exist for further expansion of advanced and extended practice roles for dietitians to meet future health-care demands.

**Key words:** advanced practice, credentialing, dietitian, economic evaluation, gastrostomy, workforce.

**Introduction**

The evolution of advanced practice health professional roles in the Australian health system has been driven by the need to provide cost-effective, safe and patient-centred models of care in response to increasing clinical demand and consumer expectations. This mirrors international experience and the prevalent global interest in value-based health care, with its underpinnings in patient-related outcomes measurement, quality and safety, and health-care system and workforce reform.<sup>1,2</sup>

A number of successful health workforce reforms in Australia have been delivered following the release of the *National Health Workforce Innovation and Reform Strategic Framework for Action 2011–2015*,<sup>2</sup> comprising numerous advanced and extended practice roles including nurse

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endoscopists,<sup>3</sup> extended care paramedics,<sup>3</sup> primary contact physiotherapists in hospital emergency departments<sup>3</sup> and prescribing by health professionals other than medical staff.<sup>4</sup> These reforms have been characterised by demonstration of medical staff role substitution as a result of workforce or skill shortages, and formal credentialing processes to manage risk and ensure safe practice. Evaluations of these novel roles demonstrated improvements in timely access to care at reduced cost.

The Australian dietetics profession has been active in this space over recent years and the number of advanced and extended practice roles and procedures introduced into the Australian health-care setting continues to slowly grow. Published examples of the successful introduction of novel advanced and extended practice roles include a dietitian-led gastroenterology clinic service,<sup>5</sup> post-pyloric feeding tube placement in critically ill patients,<sup>6</sup> and dysphagia screening and intervention.<sup>7</sup>

Gastrostomy tubes (g-tubes) are commonly utilised for long-term administration of liquid nutrition/formula for patients who cannot maintain adequate nutritional status by oral intake. There has been continued growth in the number of children and adults with g-tubes living in the community because of advancements in medical care and feeding tube technology, the aging population, and patient choice.<sup>8</sup> This cohort represents a diverse and complex group of patients requiring a significant level of resources for their ongoing clinical and care coordination needs.<sup>9,10</sup>

Traditionally, care tasks related to g-tube management such as appropriate tube selection, scheduling and performing g-tube procedures, stoma site skin care, prescribing formula type and regimen, troubleshooting complications, and ordering formula and consumables are provided in numerous community and hospital care settings by multiple health professionals including dietitians, nurses and doctors.<sup>10</sup> International studies demonstrate that this situation results in fragmented and delayed patient care, poorer patient experience and suboptimal health system productivity.<sup>8,9</sup> The impact of this traditional care model on patients and the health-care system has been under-researched in Australia, and there is scant literature pertaining to the practice of g-tube procedures performed by dietitians in the context of providing comprehensive clinical care.

Precedent for an advanced practice dietitian role in gastrostomy management in Australia is attributed to the Alfred Hospital. A successful gastrostomy credentialing program for dietitians commenced at this health-care network in 2005. This hospital service model aimed to facilitate timely and streamlined outpatient clinic care for patients with g-tubes living in the community and residential care facilities, who had been experiencing increasing emergency department presentations and lengthy waiting times for routine g-tube care traditionally provided by a medical specialist.

In 2015, the Victorian Department of Health and Human Services (DHHS) awarded allied health advanced practice funding grants to six Victorian health-care networks to develop hospital-based advanced practice dietitian roles in

g-tube management with an aim of increasing such roles in the health workforce. In the context of this herein study undertaken in Victoria, Australia, advanced practice health workforce roles are defined as roles that fall within the recognised scope of practice for a profession, but traditionally through custom and practice have been performed by other professions.<sup>11–15</sup>

The present study aimed to:

- 1 Evaluate the development and impact of the introduction of advanced practice dietitian roles in g-tube management into the workforce of participating health-care networks, highlighting lessons for progressing advanced practice roles in dietetics practice and policy.
- 2 Develop an advanced scope of practice pathway to competency to inform implementation of other advanced scope of practice dietetic roles.
- 3 Conduct an economic analysis to evaluate the overall impact on the health system.

## Methods

A questionnaire was developed to elicit information from the service lead dietitians at each health-care network regarding the following outcomes of interest. These included service changes (e.g. number of dietitians credentialed, dietitian service events, diverted service events (defined as activity previously undertaken by another health professional), adverse patient events, change in patient waiting times to access g-tube care from a health professional), enablers and barriers for the implementation of the novel advanced practice roles (including pre-, during, and post-implementation) and staff satisfaction.

Participants were also asked to describe the practice pathway to competency for implementation of their role, to inform implementation of other advanced scope of practice dietetic roles in Australia. A previously published advanced practice pathway to competency in the workplace<sup>16</sup> was included as a prompt for each participant to describe the competence pathway used within their project.

The service lead dietitians were invited to participate through an email invitation, with one reminder sent 2 weeks later to optimise the response rate. Ethical approval to undertake this evaluation was obtained from the Eastern Health Human Research Ethics Committee, approval number LR82/2016. The questionnaire was completed twice by participants: at the completion of the funded projects in October–November 2016, and to elicit 12-month post-funding outcomes in October–November 2017. Consent was implied through return of completed questionnaires.

Questionnaire responses were analysed descriptively (quantitative statements, e.g. number of dietitians credentialed) and thematically (qualitative statements, e.g. enablers and barriers) by one author and verified by a second author.

Practice pathways from each participant were synthesised by three authors (NS, KL, JP) to form an advanced scope of practice pathway to competency.

An economic analysis was also undertaken to estimate health system/financial impacts of the implementation of the advanced practice roles. Costs for hospital admissions and procedures and hourly rates for dietitian and medical staff involved in providing care for patients requiring g-tube procedures were determined by one health-care network in conjunction with their clinical costing department and applied to other participating health-care networks. Initial government grant funding was excluded from the economic reporting. All costs are reported in Australian dollars.

This research has been reported to comply with the guidelines of the Standards for Quality Improvement Reporting Excellence (SQUIRE 2.0) framework, for quality improvement studies in health care.<sup>16</sup>

## Results

Completed project evaluation questionnaires were returned from all health-care networks at the completion of the funded project time and at 12-month follow up.

*Service changes:* By the conclusion of the project grants in October 2016, five of the six participating health-care networks were successful in developing and implementing an advanced practice dietitian role in g-tube management. Four (67%) health-care networks had maintained or increased the number of advanced practice dietitian roles at 12 months, and all four sites were operating a dietitian-led g-tube management outpatient/ambulatory care clinic. At 12-month follow up, a dietitian g-tube consultative service was established at two sites to respond to g-tube-related concerns for admitted and emergency department patients and to release medical specialist time for other duties.

Table 1 summarises key outcomes at the two time points. A total of 10 dietitians were credentialed, performing more than 120 independent g-tube removal or change over procedures and contributing to over 200 service events, including diverted service events from medical inpatient consultations or specialist outpatient clinics. This has led to the avoidance of 15 emergency department presentations and/or

admissions to the short stay unit, and avoidance of 100 endoscopy unit admissions and/or radiology appointments. Importantly, no adverse events have been reported.

*Patient access to care:* Patient wait times to access health professional care for g-tube procedures decreased across all health-care networks offering dietitian-led g-tube management outpatient clinics, and reduced from up to 6 months at baseline at one health service to 0–2 days for urgent cases, and 1–2 weeks for routine care. Two sites noted staff leave and part-time working hours negatively impacted on wait times for patients during the project as low numbers of dietitians had been credentialed. Two health-care networks reported unresolved delayed access to advanced practice dietitian care on weekends and out of standard business hours.

*Economic impact:* Noteworthy health system financial savings were recorded. Conservative estimates are outlined in Table 2, and total of \$185 000 over 12 months. This represents a positive return on investment compounding into future health system efficiencies.

*Enablers and barriers to role implementation:* Enabling factors that led to successful introduction of the advanced practice roles included strong executive and stakeholder support, health department funding to provide dedicated backfill for staff training, supervision and project management, a local hospital allied health credentialing committee, and other existing advanced practice roles within the health-care network for which credentialing processes and documents were already developed. An existing dietetics ambulatory care clinic co-located with a specialty clinic enabled some health-care networks to evolve existing services into advanced practice dietitian-led clinics with medical support close by if needed.

Barriers were experienced during project establishment because of staff recruitment delays, others encountered time delays during the funded project time because of protracted internal governance approval processes required for novel advanced practice role implementation. All participants

**Table 1** Key outcomes at project conclusion and at 12-month follow up

<i>Outcome</i>	<i>October–November 2016</i>	<i>October–November 2017</i>	<i>Total</i>
Number of dietitians credentialed	5	5	10
Number of dietitians—training in progress	4	3	7
Independent gastrostomy tube changes/removals completed by credentialed dietitians	31	98	129
Emergency department presentations diverted for treatment/tube management to credentialed dietitians	4	11	15
Endoscopy unit admissions avoided for treatment/tube management to credentialed dietitians	18	56	74
Radiology appointments diverted for treatment/tube management to credentialed dietitians	6	20	26
Service events diverted from Gastroenterology/surgeon/radiologist/ stomal therapy nurse to credentialed dietitians for treatment/tube management	65	139	204
Adverse events reported as a result of credentialed dietitians performing treatment/tube management	0	0	0

**Table 2** Estimated health system savings<sup>(a)</sup>

	Cost saving per patient episode excluding feeding tube costs	Service events diverted or avoided to 12-month follow up	Total saving
Emergency department admission prevented	\$2982	15	\$44 730
Endoscopy visit prevented	\$1400	74	\$103 600
Radiology visit prevented	\$220	26	\$5720
Role substitution—dietitian instead of medical specialist	\$150	206	\$30 900
<b>Total</b>			<b>\$184 950</b>

<sup>(a)</sup> Costs were estimated by the clinical costing unit from one health-care service. Costs exclusive of feeding tube devices and consumables. Staff salaries estimated from hospital salary bulletins.

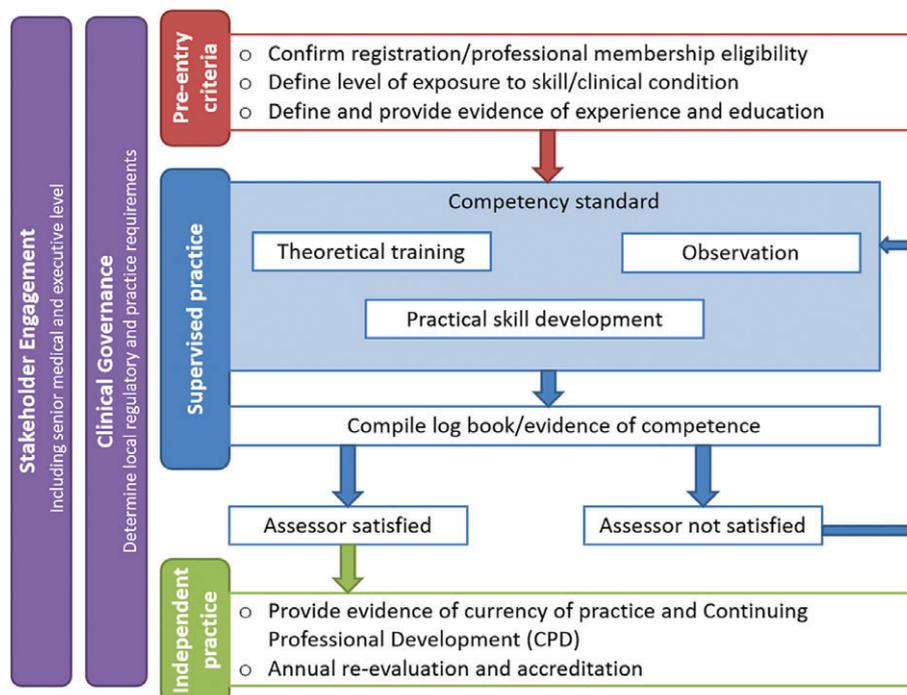
reported the extensive documentation requirements to align with existing state government frameworks and local organisational requirements to achieve internal regulatory change as time consuming. One participating health-care network site experienced staff-specific barriers amounting to resistance of support because of role boundary conflict. This could not be resolved and thus introduction of the advanced practice dietitian role was not achieved within the funded project time.

*Advanced practice pathway to competency:* The service lead dietitians at each health-care network collaborated with each other, their local stakeholders, and with dietitians from the Alfred Hospital to develop local g-tube implementation and credentialing processes. Existing relevant training and credentialing documents were also sourced and utilised.<sup>11,15,17</sup> The development of a competency pathway (shown in Figure 1) was achieved highlighting the central and ongoing importance of stakeholder engagement and clinical

governance throughout the process of advanced practice role development and successful implementation of the role into usual practice. Elements of the framework included defining pre-entry criteria, supervised practice comprising theoretical training, observation, practical skill development and competency assessment, independent practice comprising evidence of continuing professional development and currency of practice, and an annual re-accreditation process.

*Staff satisfaction:* Participants reported several positive work changes as a result of participating in the advanced practice credentialing process, including increased job satisfaction related to acknowledgement of advanced skills and expertise by other specialist and junior medical staff, the opportunity to work to full scope of practice, and opportunities for sharing their experiences with their profession.

‘(Our) dietetic skill set is valued highly by medical and gastroenterology teams and there has been an

**Figure 1** Advanced Scope of Practice Pathway to Competency.

improvement in professional recognition and working relationships'. Lead dietitian, Health Network D

Participants also reported the significant time spent by dietitians on g-tube care coordination of behalf of patients at baseline. These factors were reported to have improved at the end of the study and were sustained at 12 months for health-care networks who had maintained advanced practice dietitian roles.

Enhanced working relationship with patients and colleagues was also a feature:

'Being able to close the loop of care for patients in that we educate them pre-insertion and post-insertion, but were missing the joy they experience when their gastrostomy is removed. It has been a real thrill to see how patients cope with this and to see their faces when it is out and they are free, SO glad that we get to experience that'. Lead dietitian, Health Network C

Participants reported several advantages associated within a 'community of practice' that emerged during the project. Feeling supported, validating experiences, and working more efficiently (by sharing resources not 'reinventing the wheel') were common themes.

'(I found it) extremely rewarding – enabled by provision of dedicated funds and time in the context of strong organisational and multidisciplinary support. Working within the community of practice – with all members sharing the same goal (i.e. positive outcomes for patients) was great. The timeframe ensured that the project kept moving and that tangible results were achieved... a fantastic outcome for our patients and for the dietetic staff involved'. Lead dietitian, Health Network A

## Discussion

Government funding to develop and introduce advanced practice dietitian roles in g-tube management into the workforce of six participating health-care networks was successful in five sites and sustained and expanded at 12 months in four sites. An advanced scope of practice competency pathway to inform implementation of other advanced practice dietetic roles was developed, and an economic analysis to evaluate the overall impact on the health system conducted.

The underlying workforce drivers for development of this advanced practice role are similar to those previously reported in the UK; insufficient capacity of nurses,<sup>8</sup> and in the present study, medical staff. Also similar to both studies were the benefits to patients from the advanced practice dietitian role—preventing avoidable hospital admissions, the provision of a central contact point, cost savings, and enhanced access and expertise.

Factors contributing to a negative patient experience at baseline as reported by participants included limited access

to appropriately trained specialist staff leading to long wait times and delayed resolution of issues, unnecessary emergency department, endoscopy and/or radiology department presentations and unplanned hospital admissions for emergency procedures. Complex navigation of the health-care system by patients and their families involving multiple health professionals and appointments was a feature.

These advanced practice roles align with the vision and goals of the recent Victorian state government 'Health 2040: Advancing health, access and care' report of 'better health, better access, better care' for Victorians,<sup>18</sup> and responds to the calls for action to make better use of the skills and capabilities of the workforce, assign resources to deliver the greatest value and benefit for individuals, and a more integrated approach to ensure patients experience services as one system, and receive care tailored to their needs.<sup>18</sup>

Participants who had successfully introduced the new advanced practice dietitian roles reported a range of new skills attained during the credentialing process. The acquisition of advanced clinical skills including g-tube identification and selection, stoma site assessment and care, and g-tube removal and replacement procedures, had traditionally been performed by other professions. In addition, participants reported improved knowledge and skills relating to the quality improvement project cycle and valued the opportunity to contribute to the development of multidisciplinary pathways and sustainable models of care that addressed known service gaps and clinical demand, and improved access to care for patients.

During the initial project grants, a 'community of practice', defined as 'a group of people who share a craft and/or a profession'<sup>19</sup> emerged, with all participants involved in collaborative activities including one face-to-face meeting, regular teleconferences and email communication, sharing of resources, and workplace visits to observe services and practice within the group. This 'community of practice' approach has previously been effective in facilitating and supporting professional development and practice within the dietetics profession.<sup>20</sup>

Enablers and barriers to implement and sustain practice change were also identified. The recurring theme of stakeholder engagement and support as an enabler was evident with respondents reporting a wide range of existing staff and department relationships at baseline including: chief allied health and chief medical officers, medical and nursing heads of departments in Radiology, Emergency, Outpatients and Endoscopy, other staff specialists (gastroenterologists, surgeons, stomal therapy nurses, clinical nurse consultants, other credentialed dietitians), other allied health advanced practitioners and dietitians working in community and private practice settings.

Barriers were experienced during project establishment because of staff recruitment delays, others encountered time delays during the funded project time because of protracted internal governance approval processes required for novel advanced practice role implementation. Several health-care networks have since experienced attrition of credentialed dietitians because of staff turnover. Similar to the report of

Stanley and Borthwick,<sup>21</sup> the only significant instance of role boundary conflict was experienced by a dietitian aiming to develop an inter-professional g-tube clinic, and a specialist nurse. These were unable to be resolved in one of the health-care networks and the new service was not implemented.

Patient and health system benefits were realised, with streamlined processes and reduced wait times for patients to access care. Financial savings were driven by role substitution and decreased utilisation of hospital admissions and appointments. Noteworthy, health system savings represent a return on investment for the initial health department funding outlay and will be further offset by future activity in these advanced practice roles.

Several limitations of the service implementation and evaluation are acknowledged. Due to the multiple grant submissions and diversity of pre-existing services at the six health services, there were slight variations in project implementation. Also, to ensure that a consistent model was applied across the economic evaluation, costs were estimated by the clinical costing unit from one health-care service only. Variations between health services in clinical and staff costs may exist; as such actual costing may have slight differences to those presented. In addition, an evaluation of the advanced scope services from the perspectives of patients was outside the scope of this research.

Future directions for clinical practice and research include the formalisation of a health professional learning program to facilitate expansion of this role into other hospitals and community settings; incorporating e-learning modules, practical face-to-face training, simulation assessment, supervision and re-credentialing protocols. These initiatives would benefit from defined evaluation strategies including economic evaluation.

Opportunities for further expansion of this and other novel advanced and extended practice roles for dietitians in the Australian context have been identified and a practice pathway synthesised within this research. Dietitians have a growing opportunity to work with policy-makers, health-care providers, consumers and regulatory agencies to continue to innovate, evaluate and embed advanced and extended practice roles into the workforce<sup>22,23</sup> to meet future health-care demands and grow our influence as a profession in effecting positive health outcomes for the community.

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## Conflict of interest

The authors declare that there are no conflicts of interests.

## Authorship

All authors conceived the research; NS and JP developed the questionnaire and facilitated data collection, NS drafted the manuscript. All authors have reviewed this version of the manuscript and approved its submission for publication.

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## ORIGINAL RESEARCH

## Evaluating the effectiveness of a nutrition assistant role in a head and neck cancer clinic

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**Abstract**

**Aim:** Acute toxicities secondary to (chemo)radiation for head and neck cancer can substantially impact nutritional intake. Nutrition is usually managed by dietitians, although time constraints may limit capacity to sufficiently deal with complex nutritional issues. The aim of the present study was to determine the effectiveness of a nutrition assistant performing screening and intervention of patients in a multidisciplinary head and neck clinic.

**Methods:** A model of care was developed to guide nutrition assistant practice within the clinic, with training provided to nutrition assistants prior to the clinic's implementation. Outcomes, including amount of dietitian time managing high risk patients, weight change over the duration of treatment, timing of initiation of enteral feeding and patient satisfaction were compared with pre- and post-implementation of the nutrition assistant role.

**Results:** Ninety-one patients were included, 43 pre-implementation and 48 post-implementation. Overall, (n = 21, 44%) of patients met criteria for nutrition assistant screening or intervention. Mean weight change between groups was comparable both during (−5.6% vs −4.7%, *P* = 0.3) and post-radiotherapy (−6.6% vs −6.49%, *P* = 0.9). Following implementation of the role significant improvement was found for overall patient satisfaction ( $4.0 \pm 1.1$  vs  $4.6 \pm 0.61$ , *P* = 0.03), and the dimensions: patient-perceived benefit ( $3.8 \pm 0.69$  vs  $4.4 \pm 0.62$ , *P* < 0.01) and dietitian/nutrition-assistant interpersonal skills ( $3.91 \pm 1.1$  vs  $4.6 \pm 0.55$ , *P* = 0.02).

**Conclusions:** The nutrition assistant role resulted in improved patient satisfaction and maintenance of nutritional outcomes demonstrating the effectiveness of this role in supporting the management of head and neck cancer patients within a multidisciplinary treatment clinic.

**Key words:** cancer, head and neck cancer, nutrition, nutrition assistant, radiotherapy.

**Introduction**

Head and neck cancers include tumours of the oral cavity, salivary glands, paranasal sinuses, larynx and pharynx. In Australia, the number of new cases of head and neck cancer for 2017 was projected to be 4955.<sup>1</sup> This is an increase of more than 1935 new cases since 2007.<sup>2</sup> Head and neck cancers are treated by surgery, radiotherapy or chemotherapy, or any combination of these modalities. Radiotherapy or chemoradiotherapy, given either definitively (primary

treatment) or postoperatively, is delivered over a period of five to seven weeks and is associated with significant acute toxicities including mucositis (mouth ulceration), dysphagia (difficulty swallowing), dysgeusia (altered taste) and xerostomia (dry mouth) which have a substantial impact on nutritional status.<sup>3</sup> The prevalence of malnutrition in patients with head and neck cancer can be as high as 50% prior to treatment, with further exacerbation of malnutrition occurring secondary to acute and late treatment toxicities.<sup>3,4</sup> The adverse effect of malnutrition on outcomes, including mortality and quality of life, has been well reported.<sup>5–7</sup> Evidence-based guidelines for the nutritional management of patients with head and neck cancer recommend weekly contact with a dietitian to improve outcomes in patients receiving radiotherapy based on results from multiple randomised trials.<sup>8</sup> This recommendation leads to a substantial requirement for dietetic services in this patient group.

Head and neck cancer patients receiving curative intent radiotherapy or chemoradiotherapy at Peter MacCallum Cancer Centre are managed in a twice-weekly multidisciplinary

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on-treatment clinic which includes radiation oncologists, dietitians, speech pathologists and nurses. Approximately, 40–50 head and neck cancer patients are on treatment at any one time, with between 20 and 30 patients attending each multidisciplinary clinic. Currently, all patients attending this clinic are seen weekly by a dietitian during radiotherapy and then fortnightly for up to six weeks post-radiotherapy in a model of care previously described.<sup>9</sup>

Nutrition assistants (NAs) are allied health assistants (AHAs) who specifically work with dietitians. NAs are trained to work within a certain scope of practice undertaking tasks designated and specified by dietitians. NAs currently work in the inpatient and ambulatory chemotherapy settings at Peter MacCallum Cancer Centre, performing malnutrition screening to identify patients at risk of malnutrition, as well as provision of basic nutrition intervention. While patients were seen by the dietitian weekly in the multidisciplinary head and neck clinic, due to the volume of patients there was often insufficient time to spend with those who had complex nutritional issues. Therefore, there was scope to implement an NA role in the head and neck multidisciplinary clinic to screen certain patients for nutrition problems, and provide basic nutrition interventions, thereby releasing dietitian time for the management of patients with more complex needs including those who are nutritionally unstable. The aim of the present study was to determine the effectiveness of an NA role performing screening and intervention in lower risk patients within the head and neck clinic on nutritional outcomes, dietitian time and patient satisfaction through comparison of two models of care.

## Methods

This was a prospective pre- and post-test study of two consecutive, independent cohorts of patients attending the twice-weekly multidisciplinary head and neck clinic between November 2015 and March 2016 to compare outcomes under the previous model of care with the new model of care. Prior to implementation of the NA role (pre-implementation cohort) data were collected between November and December 2015. Following implementation of the NA role (post-implementation cohort) data were collected between February and March 2016. The pre- and post-implementation cohorts were separated by a 1-month settling in period to embed the new model of care prior to evaluation. Patients were eligible for the study if they had a primary diagnosis of head and neck cancer, were over 18 years of age and had the ability to understand and complete surveys. Patients were excluded from the study if they were receiving treatment with a palliative intent. The study was approved by the Peter MacCallum Cancer Centre Human Research Ethics Committee (15/116L). The study followed the Standards for Quality Improvement Reporting Excellence (SQUIRE 2.0).<sup>10</sup>

In the previous model of care, all patients attending the multidisciplinary head and neck clinic were automatically seen by the dietitian weekly during radiotherapy and then

fortnightly for up to six weeks following radiotherapy. Patients were seen by the other disciplines present in the clinic in the same location, but under a separate appointment. NAs were not present in the clinic. The new model of care was established to introduce the NA role and guide the NAs practice within the clinic (Figure 1). Patients were always seen by the dietitian in the first and final week of radiotherapy as these were deemed important time points for dietetic intervention. At the time of the weekly dietitian review, dietitians identified patients who met the criteria for NA screen and intervention the following week. Excluding these time points, the weekly dietitian review could be replaced by NA review at any time during or post-treatment. Patients who were receiving enteral nutrition were always seen by the dietitian. An eight-week training module was developed to upskill two NAs knowledge of the operation of the head and neck cancer clinic, use of the screening tool and triggers for referral back to the dietitian (Appendix S1, Supporting Information).

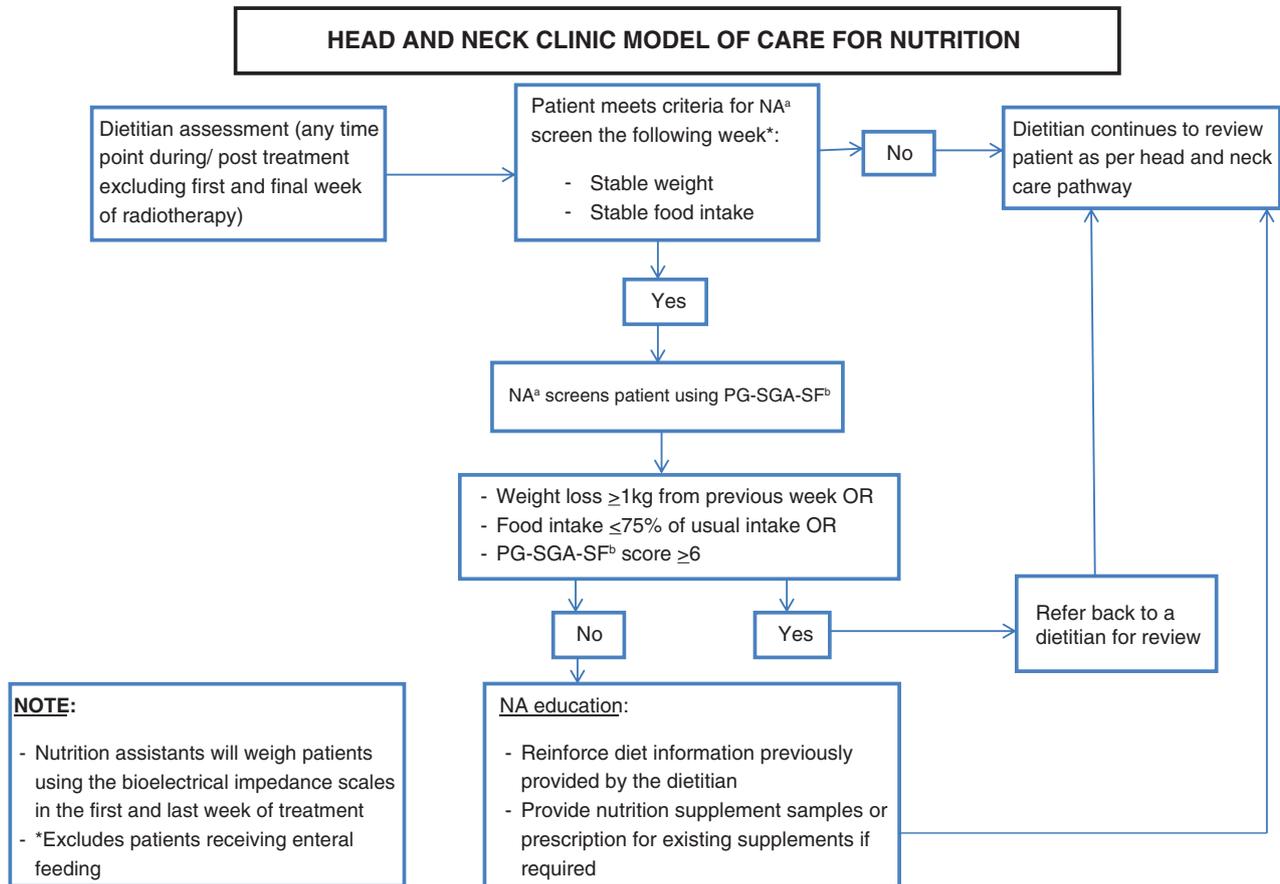
Data on participant demographics including age, gender, tumour type and stage, and treatment were obtained from the hospital electronic medical record.

Patients' weight at the commencement and end of radiotherapy, and at four weeks post-treatment, was collected from the dietitians assessment in the electronic medical record. Percentage change in weight at the end of and at four weeks post-treatment relative to weight at commencement of treatment was calculated. The mean percentage weight loss over these time periods was compared between the pre- and post-implementation groups.

The number of patients with a percutaneous endoscopic gastrostomy (PEG) tube inserted either prophylactically prior to the commencement of radiotherapy or within the first few weeks of treatment, and those in whom a nasogastric feeding tube was placed during treatment were recorded. The time to commencement of enteral feeding, through either type of feeding tube, measured from the start of radiotherapy was compared between groups to determine if the replacement of dietitian reviews with NA reviews delayed commencement of enteral feeding.

The total amount of time (minutes) spent with the dietitian per patient from the commencement of radiotherapy up to six weeks post-treatment was determined from reports within the electronic Activity BarCoding system used by dietitians to record clinical and non-clinical activity. NA time was unable to be recorded using this system. At the commencement of the treatment, patients were classified into nutrition-risk criteria in order to determine the proportion of dietitian time spent with each patient-risk category (Figure 2).

Patient satisfaction was measured using the modified Patient Satisfaction with Clinical Nutrition Services (PSCNS) questionnaire.<sup>11</sup> The PSCNS questionnaire, validated in the oncology population, consists of nine items which measure overall satisfaction with nutritional care, as well as two dimensions of nutrition services: (i) dietitian/NA interpersonal skills and (ii) patient-perceived benefits of the nutrition care received.<sup>11,12</sup> Satisfaction with each item is measured on a five-point Likert scale that ranges from



**Figure 1** The model of care implemented with the introduction of the nutrition assistant role into the head and neck cancer clinic. (<sup>a</sup>nutrition assistant; <sup>b</sup>patient-generated subjective global assessment short form.)

strongly disagree (1) to strongly agree (5).<sup>11,12</sup> All participants were mailed the PSCNS questionnaire upon discharge from the clinic at six weeks post-treatment and were informed that survey responses would be analysed by a researcher independent of the clinicians who provided their care in the clinic in order to maintain confidentiality of their responses.

Sample size was pragmatic and based on similar time frames for the two models of care. Demographic and clinical characteristics of the participants were summarised using descriptive statistics. Data were analysed using Stata version 13 (StataCorp LP, College Station, Texas, USA). Independent sample *t*-tests compared mean weight and mean score of the pre- and post-implementation groups for overall patient satisfaction and the two dimensions: patient-perceived benefit and dietitian/NA interpersonal skills. Clinically important differences were considered as: percentage weight change  $\pm 0.5\%$ ; patient satisfaction 0.3–0.5.<sup>11,12</sup> Alpha was set at 0.05 (two-tailed) for all analyses.

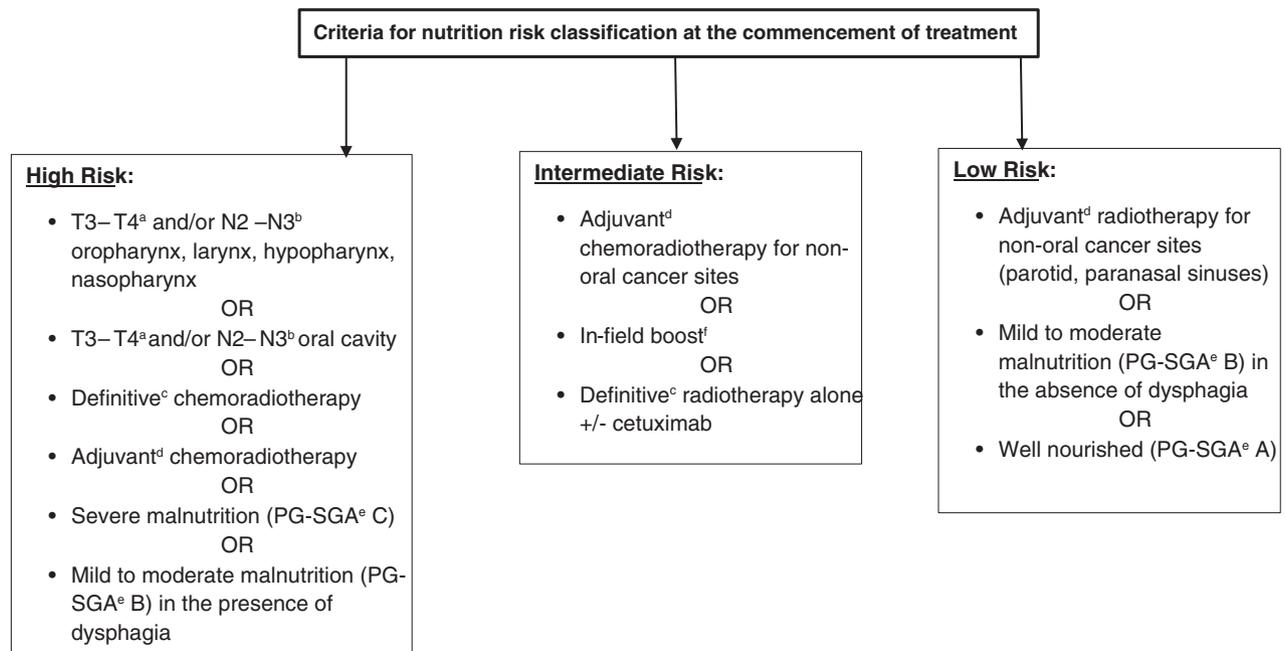
## Results

In total,  $N = 91$  patients were eligible for inclusion in the study,  $n = 43$  in the pre-implementation period and  $n = 48$

during the post-implementation period. Patient characteristics at the commencement of radiotherapy were similar in both groups (Table 1). The number of high, intermediate and low risk patients were evenly distributed across both groups. In the pre-implementation period there were  $n = 35$  (81.4%) high risk,  $n = 7$  (16.3%) intermediate risk and  $n = 1$  (2.3%) low risk patients. In the post-implementation period there were  $n = 39$  (81.3%) high risk,  $n = 7$  (14.6%) intermediate risk and  $n = 2$  (4.2%) low risk patients.

Following implementation of the NA role,  $n = 21$  (43.8%) patients met the criteria for NA screening and intervention. Only  $n = 4$  (19%) of these patients required a same day referral back to the dietitian. Two low risk, two intermediate risk and one high risk patient were identified for a NA screen at more than one time point. The average time patients were identified to see the NA was in week 3 of radiotherapy, with this being slightly earlier in high risk patients and slightly later in lower risk patients (Table 2).

The proportion of dietitian time spent with high risk patients did not differ among the groups. Pre-implementation, 88% of dietitian time was spent with high risk patients, 11% with intermediate risk and 1% with low risk patients. Post-implementation 86% of dietitian time was spent with high risk patients, 12% with intermediate risk and 2% with low risk patients.



**Figure 2** Criteria for classification of patients at the commencement of treatment into high, intermediate or low nutrition risk. (<sup>a</sup>classification of tumour size according to the American Joint Committee on Cancer Staging (AJCC); <sup>b</sup>classification of lymph node involvement according to the AJCC; <sup>c</sup>primary treatment; <sup>d</sup>additional treatment given after the primary treatment; <sup>e</sup>patient-generated subjective global assessment; <sup>f</sup>additional radiotherapy delivered in a large dose to the tumour.)

The mean percentage weight loss did not differ between the pre- and post-implementation cohorts either between the start and end of radiotherapy (–5.6%, SD 4.4 vs –4.7%, SD 3.8,  $P = 0.23$ ) or between the start of radiotherapy and four weeks post-completion of treatment (–6.6%, SD 5.3 vs –6.5%, SD 4.9,  $P = 0.91$ ).

In total,  $n = 18$  (42%) patients received enteral feeding through a nasogastric tube in the pre-implementation cohort and  $n = 14$  (29%) in the post-implementation cohort. The time to the commencement of feeding through the nasogastric tube did not differ between the pre- and post-implementation cohorts (33 days, SD 10 vs 31 days, SD 10, respectively,  $P = 0.24$ ). In total,  $n = 9$  (19%) patients received enteral feeding through a PEG tube in the pre-implementation cohort and  $n = 23$  (46%) in the post-implementation cohort. Time to commencement of feeding through the PEG tube was longer in the post-implementation cohort compared to the pre-implementation cohort but did not reach statistical significance (13.7 days, SD 13 vs 7.1 days, SD 7.8, respectively,  $P = 0.95$ ).

Thirty-eight patients returned the PSCNS questionnaire, with a 49% response rate pre-implementation and 35% post-implementation. A clinically and statistically significant improvement in all dimensions of patient satisfaction was observed following the implementation of the NA role into the head and neck clinic (Table 3).

## Discussion

The present study describes the effect of implementing a NA role in a multidisciplinary head and neck cancer clinic

through comparison of two models of care. To our knowledge it is the first time such a role has been implemented in this setting and in this patient population. Patients with head and neck cancer undergoing radiotherapy have a high requirement for dietetic services due to the high prevalence of malnutrition both prior to and during treatment and the development of significant treatment related toxicities which impact on nutritional intake.<sup>3,4</sup> Current recommendations for nutritional management are for weekly dietitian contact during radiotherapy which has demonstrated improved patient outcomes.<sup>8</sup> A recent evaluation of a weekly speech pathology and dietetic service model for head and neck cancer patients during (chemo)radiotherapy has questioned whether this level of intensity is required for all patients and if this is the most efficient use of clinician time.<sup>13</sup> In the setting of growing numbers of people diagnosed with cancer and increasing complexity of patients, it is important to evaluate innovative models of care to meet demand for regular and proactive nutritional management, while maintaining quality of care and nutritional outcomes. In the current study, this was intended to increase time for dietitians to manage complex patients.

A substantial proportion of patients were identified as meeting the criteria for NA screening and intervention. This is reflective of the findings of the above-mentioned evaluation of the weekly speech pathology and dietetic service model where it was reported that 24% of scheduled speech pathology and dietetic sessions were perceived as not necessary by either the patient, clinician or both.<sup>13</sup> While it was anticipated that the NA role would be utilised most with low risk patients, and thereby increase dietitians time to

**Table 1** Patient demographics (N = 91)

Characteristic	Pre-implementation cohort (n = 43)	Post-implementation cohort (n = 48)
Age (years), median (IQR)	62 (56–70)	63 (55–74)
Gender, n (%)		
Male	33 (76.7)	38 (79.2)
Female	10 (23.3)	10 (20.8)
Tumour type (%)		
Oral cavity	12 (27.9)	10 (20.8)
Oropharynx	19 (44.2)	28 (58.3)
Nasopharynx	4 (9.3)	1 (2.1)
Hypopharynx	0 (0)	3 (6.3)
Larynx	7 (16.3)	3 (6.3)
Paranasal sinuses	1 (2.3)	1 (2.1)
Salivary	0 (0)	2 (4.2)
Disease stage, n (%)		
I	6 (14.0)	1 (2.1)
II	0 (0)	2 (4.2)
III	10 (23.3)	12 (25.0)
IVa	27 (62.8)	30 (62.5)
IVb	0 (0)	3 (6.3)
RT dose delivered (Gy), median (IQR)	70 (66–70)	70 (60–70)
RT duration (days), mean (SD)	43.6 (4.7)	42.3 (5.5)
Surgery prior to RT, n (%)	19 (44.2)	21 (43.8)
Received Cetuximab, n (%)	1 (0.02)	1 (0.02)
Concurrent chemotherapy, n (%)		
No	18 (41.9)	10 (35.2)
Yes	25 (58.1)	31 (64.6)
Weekly cisplatin	10 (41.7)	10 (31.3)
Cisplatin week 1, 4, 7	10 (41.7)	12 (37.5)
Weekly carboplatin	3 (12.5)	10 (31.3)
Cisplatin/capecitabine	1 (4.2)	0 (0)
Weight (kg), median (IQR)	76.2 (61.8–93.7)	73.7 (62.8–85.4)
BMI (kg/m <sup>2</sup> ), median (IQR)	25.1 (21.8–30.3)	25.7 (22.3–28.6)

BMI, body mass index; IQR, interquartile range; RT, radiotherapy.

**Table 2** Utilisation of nutrition assistants in the head and neck clinic

Risk category	Identified for NA screen, n (%)	Met the criteria for same day referral back to dietitian, n (%)	Identified for multiple NA screens, n (%)	Median week of RT identified for NA screen, mean (SD)
Low risk	2 (100)	1 (50)	2 (100)	3.5 (0.7)
Intermediate risk	5 (71)	2 (40)	2 (40)	3.2 (1.1)
High risk	14 (36)	1 (7)	1 (7)	2.8 (1.1)
Total	21 (44)	4 (19)	5 (24)	3.0 (1.0)

NA, nutrition assistant; RT, radiotherapy.

**Table 3** Patient satisfaction with nutrition services score in the pre- and post-implementation cohorts

Dimension	Pre-implementation cohort, n = 21 Mean (SD)	Post-implementation cohort, n = 17 Mean (SD)	Mean (SEM) difference	P-value
Overall satisfaction	4.00 (1.1)	4.65 (0.61)	0.65 (0.28)	<b>0.03</b>
Perceived benefit	3.80 (0.69)	4.41 (0.62)	0.61 (0.21)	<b>0.01</b>
Interpersonal skills	3.91 (1.1)	4.59 (0.55)	0.68 (0.28)	<b>0.02</b>

Bold values represent statistical significance.

spend with high risk patients, high risk patients made up the majority of the patient group with only very small number of low risk patients across both cohorts. Therefore, in

reality the NA role was utilised across patients from all risk categories, while the low proportion of same day referrals back to the dietitian indicated this was both a feasible and

appropriate use of the NA role. This indicates the implementation of the NA role achieved the goal of releasing dietitian time for patients with more complex needs such as intolerance to enteral feeds or multiple symptoms affecting nutritional intake, albeit in a way that was not anticipated prior to the study. The timing of the NA screening and intervention occurred on average within the first three weeks of radiotherapy indicating the NA screening and intervention appeared to fit best prior to the onset of radiation-induced toxicities which are more likely to occur after the third week of treatment. However, it is possible that a higher number of patients may have been suitable for NA screening and intervention, including at later points in radiotherapy. The adjustment to the change in practice may have meant that the dietitians did not identify all of the patients suitable for a NA screen despite allowing a one-month settling in period to embed the new model of care. Further efficiency may be gained by a nurse or NA themselves identifying suitable patients.

A concern with replacing patient nutritional reviews undertaken by a dietitian with screening by a NA is the potential to negatively affect nutritional outcomes, particularly since the literature demonstrates improved patient outcomes with weekly dietitian contact.<sup>8,14</sup> Our study has demonstrated that nutritional outcomes were maintained with this innovative model of care. Mean weight loss and the time to commencement of enteral feeding, in patients with a nasogastric tube, did not differ between the cohorts and is similar to results reported in previous studies.<sup>9,15</sup> While the time to commencement of enteral feeding was longer post-implementation in patients with a PEG, this is most likely due to the small number of patients in the pre-implementation cohort who had a PEG rather than an indication of poorer nutritional outcomes. Furthermore, although not statistically significant, patients in the post-implementation group had a mean weight loss of less than 5% between the start and end of radiotherapy which is an important goal in the nutritional management of cancer patients because more than 5% weight loss is an indicator of malnutrition.<sup>16,17</sup>

One study reporting the introduction of an AHA role in the ICU setting reports improved patient outcomes including reduced skin breakdown and number of ventilator days. However, this was in a setting of limited baseline access to a physical therapist where the introduction of the AHA role increased patient access to physical therapy services and therefore improved patient outcomes can be expected.<sup>18</sup> The goal of introducing the NA role into the head and neck cancer clinic was to ensure nutritional outcomes were maintained while more effectively and efficiently using clinician time. The maintenance of nutritional outcomes following the implementation of the NA role supports the feasibility of using this model of care to continue adherence to current evidence based recommendations of weekly nutritional review albeit utilising a combination of dietitian and NA reviews to reduce the demand on highly specialised dietetic services.

Patient satisfaction is a key indicator of health care quality and is an important measure to consider in the evaluation of a new model of care.<sup>19</sup> Using patient satisfaction as

an outcome measure provides important patient-centred insight into the acceptability of a new model of care and may have implications for patient adherence to interventions which is essential for achieving improved outcomes.<sup>20</sup> We demonstrated a clinically and statistically significant improvement in overall patient satisfaction, as well as the dimensions of patient-perceived benefit and dietitian interpersonal skills, following the implementation of the NA role in the clinic. This is most likely because patients are receiving the most appropriate care at the appropriate time. Patients who were identified as suitable for NA screening and intervention were required to meet strict criteria, including a stable weight and having a stable food intake. Under these circumstances a short intervention by the NA, where less time is spent in the clinic, is likely to be more preferable to the patient than a comprehensive appointment with the dietitian. Likewise, patients referred back to the dietitian on the same day are likely to have been reassured their care was being appropriately monitored and actioned, also contributing to overall satisfaction, while patients who had more complex nutritional issues or were nutritionally unstable remained under the management of a dietitian. A systematic review of studies investigating AHA roles has also found increased patient satisfaction with the introduction of AHA roles, although these studies were in physical therapy or rehabilitation settings.<sup>21</sup>

There is increasing recognition that AHA roles are an important workforce with potential to support health care delivery thereby releasing highly qualified clinician time to spend on the management of patients with more complex needs.<sup>21,22</sup> The majority of the literature published on the use and effectiveness of AHA roles is in the area of general rehabilitation, physiotherapy or occupational therapy assistance.<sup>21</sup> There is a need for further investigation of AHA roles in a variety of health care settings and patient populations. AHA roles are an important step in meeting the increasing demands for health care services. However, it is important to have sufficient clarity around the role as well as clear expectations and boundaries to ensure both the AHA and the clinician have confidence in the care delivered and there is no associated clinical risk to patients. In our study this was achieved through an extensive training program in addition to a well-defined model of care.

The present study has some limitations. The model of care relied on dietitians to identify patients who were suitable for NA screening and intervention and it is possible that some patients who were suitable for NA screening and intervention were retained by the dietitian. In addition, the study did not include an economic evaluation and therefore the cost-effectiveness of this model of care has not been established.

The present study demonstrated that NAs are an effective workforce to support the delivery of evidence-based nutritional management in a head and neck cancer clinic while enabling more efficient use of highly specialised dietitian time. Results reveal that the introduction of the NA role did not compromise nutritional outcomes and increased patient satisfaction. Further studies should investigate the cost-effectiveness of introducing NA or AHA roles into new models of care.

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## Conflict of interest

The authors have no conflicts of interest to declare.

## Authorship

NK designed the study, participated in data analysis and interpretation of results, and drafted the manuscript. SG, LA, JB and JF participated in the design of the study, interpretation of results and writing the manuscript. PQ completed the data analysis, participated in interpretation of results and writing the manuscript. All authors are in agreement with the manuscript and declare that the content has not been published elsewhere.

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## Supporting information

Additional Supporting Information may be found in the online version of this article at the publisher's web-site:

**Appendix S1** Nutrition Assistant Training Manual Module describing the training provided to the nutrition assistant at dietitian-led clinic.

## ORIGINAL RESEARCH

# Developing and maintaining collaborative practice: Exploring perspectives from dietetics and speech pathology about ‘what works well’

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## Abstract

**Aim:** The aim was to support rich collaborative practice between two professions who frequently work together across both ordered and organic modes of collaboration.

**Methods:** This study uses a qualitative research approach of collaborative dialogical inquiry to explore the question ‘From the perspective of dietitians and speech pathologists, “what works well” for developing and maintaining collaborative practice?’ We deliberately chose a context where collaborative practice is evident, University Department of Rural Health (UONDRH). Participants in the research were academics and clinicians from dietetics and speech pathology. Data were sourced from our research reflections and focus group transcriptions. Analysis was dialogical and iterative.

**Results:** Beyond shared purpose, knowledge of roles and good communication, the notions of *curiosity*, *willingness* and *momentum* were at the core of ‘what works well’ for collaborative practice between dietitians and speech pathologists. Participant perspectives related to collaborative practice between these professions and beyond to other professions, and involved collaborative practice within and across healthcare organisations and a university setting.

**Conclusions:** Our interpreted themes of curiosity, willingness and momentum for developing and maintaining collaborative practice highlight the importance of paying attention to the less visible and difficult to measure aspects of patient-centred care. Questions for reflection are suggested to inform the ongoing process of developing and maintaining our and others’ collaborative practice.

**Key words:** collaboration, collaborative practice, dietetics, interprofessional education, qualitative research, speech pathology.

## Introduction

Healthcare is facing a number of well-recognised challenges, including fragmentation of healthcare, specialisation of healthcare roles, an ageing population, economic rationalisation and the need for a humanistic stance.<sup>1,2</sup> Collaborative practice is valued as a means of addressing these numerous challenges. The value of collaborative practice for patient-centred healthcare is readily apparent in the following conceptualisation:

‘Collaborative practice happens when multiple health workers from different professional backgrounds work together with patients, families, carers and communities to deliver the highest quality of care (p. 7).<sup>3</sup>

However, despite the obvious need for health professionals to practice in this way, collaborative practice is not necessarily straightforward to develop and maintain.

The variety of terms used in association with collaborative practice are indicative of the different organisational structures, contexts and ways of working together in healthcare and across health-related sectors. The terms ‘team’ or ‘network’, for example, reflect a focus on structure. Other terms, used with varying degrees of precision, involve adjectives that have varying combinations of prefixes and suffixes, for example, *multi-*, *inter-*, *trans-*, *-professional*, *-disciplinary* and *-sectoral*.<sup>4</sup> Prefixes tend to reflect the different ways of working together, including working in parallel or sequentially within defined roles (‘multi-’), combining or involving two or more roles (‘inter-’) and transcending roles (‘trans-’).<sup>4</sup> Suffixes indicate practitioners from different professions (‘-professional’), different bodies of knowledge

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(-disciplinary) and different health-related organisation or areas (-sectoral). We understand the term interdisciplinary to be indicative of, and encompass many forms of collaborative practice. Developing and maintaining collaborative practice in healthcare requires consideration of the professions, roles, discipline knowledge bases and the organisational contexts that people represent.

Developing and maintaining collaborative practice also necessitates awareness that there is not a one-size-all-fits-all definition of collaboration. Different uses of the term indicate a varying emphasis on the *people* involved (generic discipline representative or particular person with professional qualifications and experience), *place* (a defined team or a self-developed network), *process* (required forms of communication or chosen ways of interacting) and *purpose* (pre-determined outcome or unfolding innovations).<sup>5</sup> These varied emphases can be conceptualised in relation to different modes of collaboration: *ordered* and *organic*.<sup>5</sup> *Ordered modes of collaboration* have clarity of roles, guidelines, processes and expected outcomes, thereby providing a frame of reference for organisational support and different people's individual contributions. Such modes of collaboration are typically supported by team structures, guidelines and resources. In contrast, *organic modes of collaboration* arise from particular people choosing to work together opportunistically in a manner that suits their purpose and context. These less visible modes of collaboration tend to arise from people responding to and embracing the breadth of opportunities for collaborative practice. Importantly, both modes are required for competency-based practice<sup>6</sup> and patient-centred care.<sup>5</sup>

As one of the professions involved in collaborative practice, dietitians have broad scope to work in varied roles, in different ways within and across a range of sectors. The collaborative practice of dietitians is largely discussed in the literature in terms of the systems they work within (such as models of clinical care),<sup>7</sup> the focus of their work (such as healthcare prevention,<sup>8</sup> healthcare teams with clinical speciality<sup>9</sup> management of chronic disease,<sup>10</sup> and work practices<sup>11</sup>), the clinical presentations they support (such as dysphagia<sup>12,13</sup>), and details about their team roles.<sup>14–16</sup> Morris and Matthews<sup>17</sup> highlighted the importance of formal and informal communication, respect and leadership of effective collaboration within teams where dietitians work. They also identified scope to further understand the development of relationships in relation to patient-centred care, along with how to better prepare new practitioners for collaborative practice when their education may have been lacking in this area.

Ensuring that dietitians graduate with competency for collaborative practice is encompassed within the National Competency Standards for Dietitians in Australia (Domain 4.2 and 4.3). Formal and informal interprofessional education strategies within and across education institutions and healthcare organisations provide rich opportunities for student dietitians to learn how to work with other professions. This may take the form of interprofessional activities embedded into coursework<sup>18–21</sup> or interprofessional

placements.<sup>22,23</sup> In addition to formal learning strategies, our earlier research identified the importance of informal rapport-building opportunities for helping students learn to work with other professions and for educators to support them to do so.<sup>24</sup> We contend that it is important to acknowledge both the formal visible and informal less visible ways of developing and maintaining collaborative practice.

The Dietitians Association of Australia (DAA) support the ongoing development of collaborative practice through a number of role statements outlining the relationships between dietitians and other health professions.<sup>25</sup> These role statements relate to diabetes, chronic health and oral health, and the particular roles of diabetes educators, exercise physiologists and oral health professionals. Within these role statements are broad directive statements highlighting the importance of organic modes of collaboration such as '*All diabetes educators and dietitians should establish a professional working relationship with each other to ensure consistency of messages and provision of coordinated care*' (p. 6)<sup>26</sup> and clear rationale, specific guidelines and models to guide ordered modes of collaboration to support such statements. However these role statements are not seen as complete with the potential recognised for '*similar documents [that] could evolve in the future in collaboration with other disciplines*' (p. 5).<sup>26</sup>

Of interest and relevance to the authors of this article is the collaborative practice of dietitians and speech pathologists, given the clinical alignment between the two professions and our recognised interest in this domain.<sup>27</sup> It is recognised that in managing feeding and swallowing difficulties, dietitians and speech pathologists have scope to collaborate through regular, open communication and the sharing of knowledge and skills.<sup>12,13</sup> However, beyond these authors, the richness of these opportunities appear to be under-represented in the literature.

In an earlier study involving a work-integrated interprofessional education strategy for dietetics and speech pathology students, we explored the nature of interprofessional relationships.<sup>27</sup> We identified the importance of: *facilitating interprofessional mutuality, appreciating the multi-faceted nature of respect, and considering the visibility of interprofessional relationships*. These notions both relied on, and facilitated, good communication, as well as knowledge of roles, and shared purpose; well-recognised attributes of collaboration. In our current study we sought to extend our research to more deeply understand dietitians' and speech pathologists' collaborative practice within and across healthcare and education. In particular how it was developed and maintained, and how it may relate to collaborative practice beyond these particular professions. Again we were interested in those organic aspects of collaborative practice that are difficult to see and measure and easy to overlook or ignore. We wanted to make these aspects of collaboration explicit, so they could be thought about and reflected upon. The aim was to support rich collaborative practice between two professions who frequently work together across both ordered and organic modes of collaboration, and support how we work with other professions.

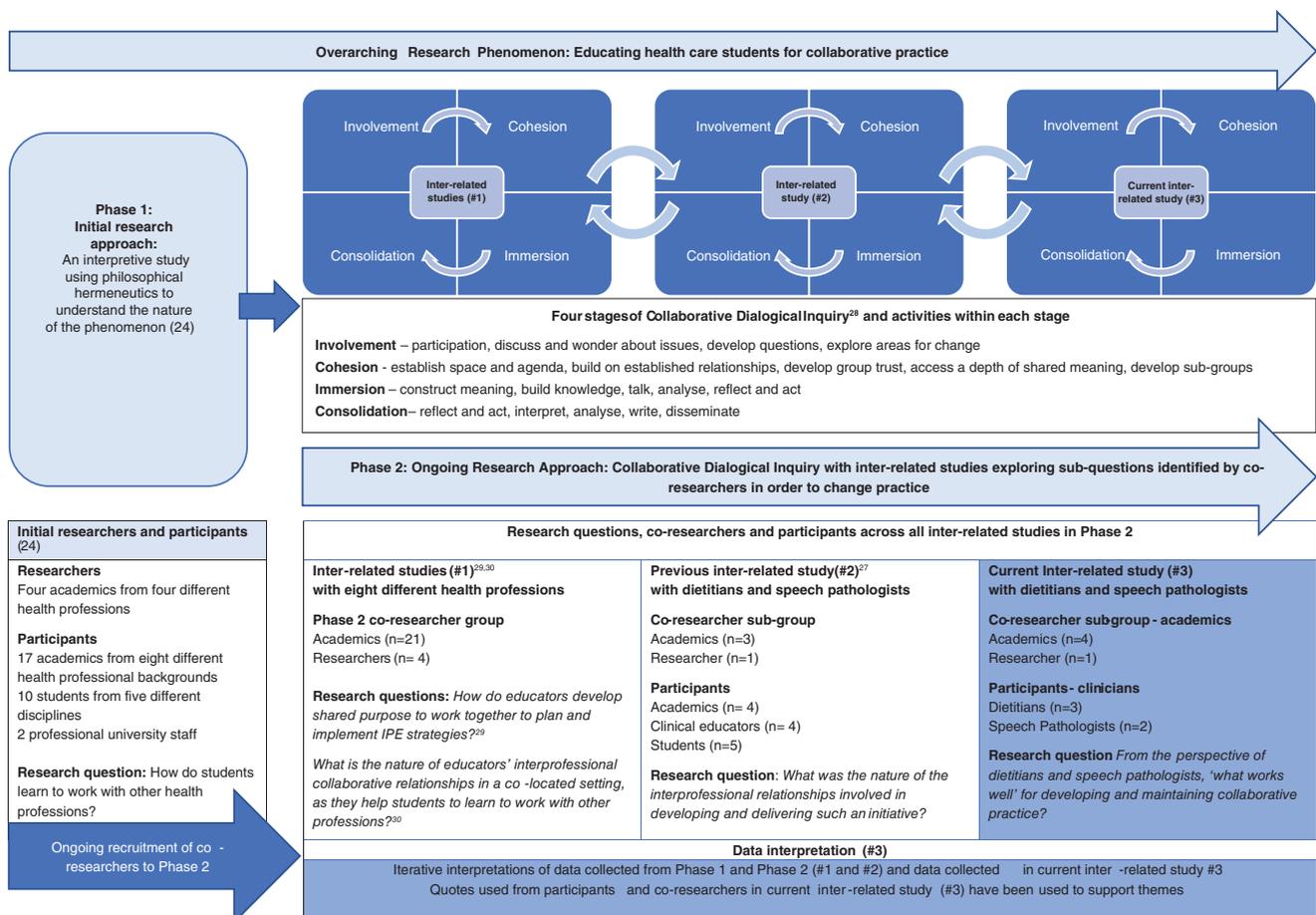
## Methods

Our current study is located within a larger research project<sup>24</sup> with two phases, as described in Figure 1. From Phase 1, key participants were invited to form sub-groups and co-produce further studies in Phase 2. In our study, (shown in Figure 1 as #3), we used a qualitative research approach of collaborative dialogical inquiry.<sup>28</sup> We explored the question ‘From the perspective of dietitians and speech pathologists, “what works well” for developing and maintaining collaborative practice?’ Collaborative dialogical inquiry was suitable for exploring organic modes of collaboration and enabled the research to be undertaken with dietitians and speech pathologists rather than on them. This approach was used to enable co-production of knowledge and to ensure that issues explored were relevant to the collaborative practice of these two professions. The four stages of collaborative dialogical inquiry (involvement, cohesion, immersion in issues, and consolidation of changed practice),<sup>28</sup> provided a framework for discussing the topic. These stages enabled co-researchers to access a depth of shared meaning, construct meaning, build knowledge, interpret, reflect and develop insights. Relationships between co-researchers were important for the instigation

of the research, and were integral to our collaborative dialogical inquiry and the research context (i.e. where collaborative practice happens).

Our research team of three dietitians, one speech pathologist and one researcher, are a sub-group of the larger co-researcher team (of 21 academic educators and researchers from eight health professions) and were involved in inter-related studies in Phase 2 (Figure 1, #1 and #2), using the same research approach to explore ‘how students learn to work with other professions and how educators support them to do so’. Two members of our research team have roles as both an academic educator and health service clinician.

The context of our research is a site of the University of Newcastle (UON) where there is a close relationship between the academic educators and health service clinicians. Students from eight professions live and learn together for times that vary from 2 weeks to the full academic year. Providing formal and informal opportunities for interprofessional education and interprofessional rapport building is an important focus of the UON. We have over a decade of experience with interprofessional learning modules and activities. This focus of our context and our experience enabled us to explore the presence of (rather



**Figure 1** Locating the current inter-related study within our larger research project: Exploring how students learn to work with other health professions

**Table 1** Overview of data sources, collection and analysis for current inter-related study exploring the question: ‘From the perspective of dietitians and speech pathologists, ‘what works well’ for developing and maintaining collaborative practice?’<sup>(a)</sup>

<i>Four data sources for interpretation and re-interpretation over a 16 weeks period<sup>(a)</sup></i>	<i>Data collection processes</i>
(i) Notes and conceptual diagrams produced during research team reflective discussions Ongoing written and verbal reflections	<b>Location and participants</b> Focus groups were undertaken at the [blinded for peer-review]. Only participants and researchers were present during focus groups. Reflections were collected individually and collectively (formal and informal)
(ii) Three focus groups with ourselves as co-researchers	<b>Focus groups</b> Focus groups were 20–45 minutes duration.
(iii) Two focus groups with four clinicians from dietetics and speech pathology Notes and reflections taken during and after the focus group Focus groups and reflective discussions were interspersed (over 16 weeks), with one informing the other in an iterative manner	<b>Repeat focus groups</b> Repeat focus groups with co-researchers were undertaken. Repeat focus groups were not undertaken with participants, as the identified themes resonated strongly with initial themes. Sufficient data was collected to answer our particular research question in our particular context.
(iv) Transcripts (from Phase 1 and inter-related studies in Phase 2), utilising relevant segments of (dietitian and speech pathologist) participant and co-researcher interviews and focus groups	<b>Recording and transcription</b> Audio recordings from focus groups were professionally transcribed and checked for accuracy.  <b>Review of transcripts</b> The focus groups represent perspectives at a particular time, therefore it was not relevant to return them to participants for correction as their perspectives may have changed as a result of participating in the interviews. Data collection and original analysis from Phase 1 <sup>24</sup> and previous inter-related studies in Phase 2 <sup>27,29,30</sup> are described elsewhere.

**Data analysis—an iterative process**

Data collected specifically to answer the current research question<sup>(a)</sup> was analysed and coded descriptively, then reanalysed to develop conceptual ‘initial themes’.



Data collected in previous studies (across Phase 1 and Phase 2) were reanalysed in relation to these ‘initial themes’ and these ‘initial themes’ were further developed to answer the current research question<sup>(a)</sup> of this study.



This process continued until there was coherence of themes across all data. Quotes to illustrate themes have been chosen from the data specifically collected for this research.

<sup>(a)</sup> All interviews and focus groups were conducted by AC (PhD), an academic researcher experienced in qualitative research methods including collaborative dialogical inquiry and with no supervisory or employment responsibility to participants.

than the absence of) developing and maintaining collaborative practice beyond the usual (and important) focus on interprofessional education. Ethics approval was received from the UON Human Research Ethics Committee and the Hunter New England Health (HNEH) Human Research Ethics Committees (HREC) Human Research Ethics Committee (UON HREC H-2012-0135 and HNEH HREC 12/08/15/12.01).

Participants in this inter-related study were ourselves as co-researchers, and clinicians (practising dietitians and speech pathologist) at the co-located health service. Data for interpretation were compiled from four sources (refer to Table 1): ongoing iterative reflections by the research team, focus groups with ourselves as co-researchers, focus groups with participants, and previous qualitative data (sourced from interviews and focus groups from

**Table 2** Participants in each phase of research by profession and role

Participants	Phase one		Phase two		Total Across both phases
	Initial research	Previous inter-related studies (#1 and #2)	Current inter-related study (#3)		
<i>Nutrition and dietetics</i>					
Educators	3 <sup>(a)</sup>	3	3		14 <sup>(a)</sup>
Clinicians		2	3		
Students	1	5	0		6
<i>Speech pathology</i>					
Educators	1	1	1		3
Clinicians	1	2	1		4
Students	3	0	0		3
TOTALS	9	13	8		30

### Invitations to participate in research phases

- Sixteen students were invited and eight chose not to participate (Phase 1 and/or previous inter-related studies in Phase 2).
- Sixteen clinicians were invited and eight chose not to participate (Phase 1 and/or previous inter-related studies in Phase 2).
- All academic educators who were invited to participate in both phases of the research participated.
- One clinician who returned a consent form could not participate in the scheduled focus group (current inter-related study).

<sup>(a)</sup>Data combined, as some participants had both academic and clinical roles.

Phase 1<sup>24</sup> and previous inter-related studies<sup>27,29,30</sup> in Phase 2).

Purposive sampling enabled data to be collected from people from the relevant professions with the appropriate roles. Participants received their invitations to participate via email or letters. The reason for the research was explained in the Participant Information Statement, as part of the process of informed consent. Signed consent was received from all participants. An overview of the professions and roles of participants contributing data for analysis is provided in Table 2. The smaller number of speech pathology participants reflects the smaller numbers of speech pathology academic educators, clinicians and students at UON. Similarly the smaller number of males reflects the smaller number of males in these professions.<sup>31</sup> The focus groups held between ourselves and with our colleagues used a lens of appreciative inquiry<sup>32</sup> to explore our topic. This lens enabled us to engage with collaborative practice in an affirming manner, looking at instances of what has been achieved and being curious about 'how it could be'. Questions are shown in Box 1. These questions were used by co-researchers in their focus groups (undertaken prior to the participant focus groups). Questions for the interviews and focus groups in the earlier part of the study were trialled before use. The phrasing of questions used in our focus groups was informed by appreciative inquiry.<sup>32</sup>

Data were managed using a combination of NVivo and colour-coding of hard copies. Data were interpreted dialogically and iteratively in order to identify key concepts that transcended the particular professions. Analysis of data was undertaken by AC (who had no supervisory or employment

### BOX 1

#### QUESTIONS INFORMED BY APPRECIATIVE INQUIRY FOR OUR AUDIO-RECORDED FOCUS GROUPS

*Tell me about a peak experience when you felt most engaged when collaborating with a speech pathologist/dietitian and really proud of your engagement?*

*Without being humble, what do you most value about yourself and the way you approach either this collaboration or collaboration in general?*

*What core factors do you think gave life to your collaborative practice at this/these time/s?*

*If you had a magic wand and could have three wishes granted to heighten the vitality of developing and maintaining collaborative practice, what would they be?*

*How might this relate to developing and maintaining collaborative practice between dietitians and speech pathologists?*

responsibility to co-researchers or participants). De-identified segments of relevant data were provided to co-researchers, as coding moved iteratively from descriptive to conceptual, though ongoing dialogue between co-researchers, as themes were interpreted from the data. Co-researchers provided continual feedback on findings. The interpretive nature of our research approach enabled us to share unfolding insights with participants during the most

recent focus groups. As we were building on our earlier research<sup>27</sup> key questions we asked of the data included: *What is involved in developing and maintaining collaborative practice? What gives rise to mutuality in collaborative practice? What role does respect play and how is it developed? In what way are visible relationships important? What other concepts do we need to consider?* These questions were informed by findings from Phase 1 and earlier inter-related studies. This iterative dialogue with data allowed us to explore resonances or challenges and develop our initial insights into conceptual themes. These themes are discussed below and illustrated with quotes from co-researchers and participants of the current inter-related study. Label identifiers have not been added due to the possibility of individual participants being identified. Quotes have been chosen for their conciseness and clarity rather than to represent a particular profession or context.

## Results

From the perspectives of dietitians and speech pathologists, the notions of *curiosity*, *willingness* and *momentum* were at the core of ‘what works well’ for collaborative practice. These themes transcended professions and contexts to encompass collaborative practice between these professions, as well as beyond to other professions, within and across our local healthcare organisations and our University (blinded for peer-review). Thus we propose that they also transcend circumscribed conceptualisations of collaborative practice as being ‘interprofessional’, ‘interdisciplinary’ and ‘intersectoral’.

*Curiosity for developing and maintaining collaborative practice:* Curiosity enabled dietitians and speech pathologists to identify situations, see possibilities and stimulate the process of working with others.

*‘I think it’s just how interested and inquisitive I am about what other people are doing and maybe why they’re doing it, what’s working and how we can all work together.’* [Participant J]

Curiosity set the scene for the mutuality at the core of collaborative practice.

*‘When you just focus on your profession you just think about your successes, which is great. But when you need to support others across other disciplines, it makes you think differently, because you’re not so focused on just one discipline.’* [Participant N]

Humility could be a precursor of curiosity through realising what can be learnt from other professions’ knowledge bases and practice.

*‘[Important for collaborative practice] is understanding that you don’t possess all the knowledge and there are other bodies of work and evidence bases that you just cannot be across, and so firstly that, and secondly you need to have an awareness of what the other role is.’* [Participant R]

Close proximity to other professions can facilitate learning about others’ roles.

*‘Because it’s interesting, just the stuff that happens out there, because people overhear something or have a chat and realise they’ve got something of interest.’* [Participant N]

However curiosity about other professions was not necessarily an innate characteristic of all individuals, nor inherent in all stages of professional development. At times it needed to scaffolded through formal learning opportunities.

*‘[Students from dietetics and speech pathology] did a presentation about “what dietitians do”, and [vice versa]. It was like a penny dropping for both sets of students. [They] said “we had no idea that you did that” [about each other’s profession]. They were gobsmacked.’* [Participant F]

Understanding more about other professions’ roles and contributions engendered respect for working together. However, although important for developing and maintaining collaborative practice, curiosity tended to be dependent on personal attributes and opportunities presented by colleagues in different professions, or arising from the workplace layout.

*Willingness for developing and maintaining collaborative practice:* Working together and negotiating complexities of collaborative practice involved willingness to move beyond simply respecting roles, to willingly embracing issues arising from the intersection of roles. This willingness was important for effective patient-centred care.

*‘[In relation to stroke rehabilitation] you may have to reduce feeds to ensure that they have enough appetite ... [for] any swallowing activity [the speech pathologist is] trying to incorporate. ... I think both players putting their thoughts forward with their reasoning behind it and listening to one another and striking an agreement as to what is best for the individual [patient’s] needs at that particular time.’* [Participant R]

Developing students’ collaborative practice involved willingness to embed and structure learning opportunities that frame interactions with other professions as normal positive practice.

*‘If we need to communicate with another discipline, I suggest that they [the student] approach them. I preface that with “they are very approachable, this is normal, ... just do it” keep it fairly casual. I think it is much better to just preface it like that [rather] than make a big deal out of it, saying “oh we might not” or “they look busy.”’* [Participant Y]

Inherent in these positive interactions is willingness to provide a safe environment for interacting and learning with and from each other.

*‘Collaboration is good ... where it goes both ways... anyone can stop the other, and everyone is willing to be involved in the collaboration and conversation. Being approachable, not being dismissive ... that safe environment where you don’t*

*feel like you are going to be laughed at or waved away.'*  
[Participant D]

While established relationships facilitate the development of collaborative practice, people also need to be willing to initiate patient-centred communication beyond their usual networks.

*'If [we have] those core factors of being open to collaboration and ... honest communication ... [while] it is ideal [to know the person] it doesn't matter if you don't as long as those baseline factors are there.'* [Participant D]

Willingness arose from and in turn fostered respect for others' contributions, and enabled opportunities for developing and maintaining collaborative practice to be grasped and maximised.

*Momentum for developing and maintaining collaborative practice:* Co-location facilitates the rich communication fuelling momentum.

*'Now that [we are] all in the same location, [we] would see [others from a different profession] on a daily basis. ... There's more discussion due to co-location, even both formally to talk about patients and informally.'* [Participant F]

However, it was important not to take collaborative practice for granted.

*'In the busy environment when you do have a lot on your plate and a busy clinical load, just being able to stop for a moment and realise the value in that interaction, possibly is a good trait to have [for maintaining collaborative practice].'*  
[Participant D]

Being open to innovation facilitated momentum for learning opportunities.

*'You're always hearing about what everybody else is doing, and your ears prick up and go "oh is that something that we can do and get involved in?" So it's the enthusiasm. ... there's this notion that nothing's out of bounds, that you can just keep going and going.'* [Participant J]

Momentum generates the aspiration for continuing to develop collaborative practice.

*'Positivity and willingness to collaborate ... it all just kind of starts to snowball I think ... and hopefully others get swept up in that and see those interactions. If [students] are seeing those kinds of behaviours being demonstrated as the norm, then hopefully they get to be part of that and want to continue it in their own professional roles.'* [Participant B]

Momentum was nurtured by relationships, fuelled by success and facilitated by contextual conditions.

## Discussion

Established collaborative practice between dietitians and speech pathologists<sup>27</sup> provided the basis for our continued

exploration of this important aspect of patient-centred care. Due to the fluid nature and widespread relevance of collaborative practice, perspectives from dietetics and speech pathology of 'what works', extended beyond instances where these professions interact (such as rehabilitation of stroke patients), to include their perspectives on working with a range of other professions. Similarly these perspectives drew on the multiple roles involved in developing and maintaining collaborative practice (e.g. as educator, clinician and clinical supervisor) and on previous and current experiences (including as students, recent graduates and experienced practitioners). Thus the collaborative practice described by participants could not be circumscribed as 'interprofessional', 'interdisciplinary' or 'intersectoral' but rather a rich intertwining of all.

Recognising both organic and ordered modes of collaboration enabled us to be sensitive to aspects of practice that can be difficult to see and challenging to measure. Accordingly we interpreted the themes of *curiosity*, *willingness* and *momentum*. These themes resonate and extend conceptualisations of positive attributes of collaboration and healthcare education within the literature.

The notion of curiosity, which tends to be associated with learning, highlights that collaborative practice involves ongoing learning about other professions, different approaches, new ways of working together and implications of following-up on opportunities. Dyche and Epstein (p. 664)<sup>33</sup> recognised the importance of curiosity for developing 'perceptive, compassionate and wise healthcare providers'. We concur with their following statements: 'Medical educators should balance the teaching of facts, techniques and protocols with approaches that help students cultivate and sustain curiosity and wonder in the context-rich, often ambiguous world of clinical medicine' (p. 663), and 'Students' curiosity is deepened and diversified when they interact with the views of others' (p. 666). Accordingly, we recognise the importance of asking questions and reflecting for developing and maintaining collaborative practice for students and graduates.

The notion of willingness is recognised as an aspect of collaboration; for example, 'willingness to cooperate and collaborate' as part of team effectiveness (p. 3),<sup>16</sup> willingness to learn from other professions as part of individual professional development<sup>34</sup> and interprofessional educators' 'willingness to change the way they educate and practice' (p.76).<sup>35</sup> While our study supports these portrayals it also highlights the importance of mutuality. As well as being willing to collaborate with and learn from other professions, our research described the importance of being willing to facilitate own and others' respect for, and positivity about, collaborating. It also highlighted the value of maximising opportunities that arise from current relationships and looking for opportunities to build other relationships.

The notion of momentum is useful as a means for emphasising that collaboration can move beyond particular situations where clinicians work together, to encompass educators' and clinicians' working together across different organisations. This notion highlights the dynamic,

interrelated nature of collaborative practice and the importance of context in presenting opportunities for developing and maintaining collaborative practice. Our findings support references in the literature to interprofessional education's momentum,<sup>36</sup> the importance of sustaining this momentum<sup>37</sup> and evidence of interprofessional education's effectiveness that can facilitate further momentum for academic staff to work together for interprofessional curriculum design.<sup>38</sup> While interprofessional education in the literature tends to refer to formal strategies, our research supports both the formal and informal opportunities of developing and maintaining collaborative practice. Collaborative relationships between and across roles and organisations, facilitated by personal contact, can build on success and in turn can create new opportunities for students, as well as educators and clinicians.

We contend that as dietitians and speech pathologists we need to continue to develop and maintain of our own and others' collaborative practice. Although we confined our exploration of perceptions to dietetics and speech pathology, and involved a small number of participants from two different settings, the in-depth nature of our interpretation enabled our themes to transcend particular professions and roles. Our findings also resonated with, and extended insights from, the literature. Insights and reflective questions arising from our findings, may therefore have relevance for a range of people and roles beyond the context of our research. Further as our themes are broad concepts they may have relevance for implementing and exploring aspects of curricula and competencies (such as DAA competencies).<sup>39</sup> However being complex and multifaceted in nature they may mean different things to different people across varied contexts and situations. Hence, rather than seeking to specifically link our themes to particular aspects of curricula and competencies, we invite readers to consider the relevance of our themes to these educational frameworks in relation to their own practice.

Box 2 contains a set of reflective questions we pose for our own and others' ongoing consideration. In seeking not to generalise our findings to other contexts, we are consistent with the qualitative research notion of transferability where the reader is recognised to be in the best position to determine the relevance of our findings and reflective questions to their own situation. Readers are therefore encouraged to alter and further develop questions that are relevant to their own situations and practice. As part of our ongoing interest in developing and maintaining collaborative practice we will continue to explore the notions of curiosity, willingness and momentum for developing and maintaining collaborative practice with our colleagues from other professions.

In conclusion, our interpreted themes of curiosity, willingness and momentum for developing and maintaining collaborative practice highlight the importance of paying attention to the less visible and difficult to measure aspects of collaborative practice for patient-centred care. Questions for reflection are suggested to inform the ongoing process of developing and maintaining our and others' collaborative practice.

## BOX 2

### REFLECTIVE QUESTIONS FOR ACADEMICS, CLINICIANS AND STUDENTS IN ORDER TO DEVELOP AND MAINTAIN COLLABORATIVE PRACTICE

#### Curiosity

- What aspects of other professions am I curious about?
- What else can I be curious about?
- How might I go about answering my questions that will appease my curiosity?
- What would I like other professions to be curious about in relation to my profession?
- How might I encourage this?

#### Willingness

- What aspects of my own collaborative practice would I like to develop and maintain?
- How might I go about this?
- When and where am I most positive about developing and maintaining collaborative practice?
- What is it about these times and situations that enables this positivity?
- How can I do more of this?

#### Momentum

- Who else can I involve in this?
- How might I go about this?
- What needs to be in place for this to happen?
- What else do I need to think about?

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The authors have no conflicts of interest to declare.

## Authorship

All authors contributed to the development of the manuscript. AC was responsible for facilitating data collection and analysis. All researchers contributed to data analysis and development of concepts.

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## ORIGINAL RESEARCH

# The contested space: The impact of competency-based education and accreditation on dietetic practice in Australia

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### Abstract

**Aim:** Competency-based Education (CBE) has underpinned the education of dietitians in Australia since the first Competency Standards (CS) were published; however, little is known about how CBE has influenced dietetic practice. The aim of this paper is to explore how a CBE framework and the CS have influenced dietetic practice in Australia since 1990.

**Methods:** A qualitative investigation explored concepts of dietetic practice. Data analysed were original interviews previously undertaken with recent graduate dietitians during 1991 (n = 26), 1998 (n = 23) and 2007 (n = 19) and seven guided discussions with dietitians and employers (n = 28) conducted in 2014 to identify themes. The DAA Competency Standards and Accreditation Manuals/Standards since 1990 were also analysed to triangulate the interview data and to investigate how the CS were interpreted.

**Results and Conclusions:** Themes identified from interviews included: (i) communicating for better care, (ii) scientific enquiry for effective practice, (iii) critical thinking and evidence-based practice and (iv) professionalism, which remained core to dietetic practice over time, but leadership, advocacy, business management and entrepreneurial skills have emerged more strongly as the scope of practice has diversified. The landscape in which dietitians' practice showed increasing complexity and clear boundaries separating professional roles were disappearing. The 2015 CS and the 2017 Accreditation Standards highlighted that competency remains a shifting construct and that professional behaviours change depending on economic and political reasons in the play of power. Accreditation policy and current standards have successfully maintained a standard of dietetic practice across a diverse country but have the potential to constrain innovation.

**Key words:** accreditation, competency standards, competency-based education, dietetics, professional competence, qualitative evaluation.

### Introduction

Competency-based education (CBE) has underpinned the education of dietitians in Australia since the publication of the first Competency Standards (CS)<sup>1,2</sup>; however, little is known about how CBE has influenced dietetic practice. The apprenticeship nature of dietetic education prior to 1993 was time-dependent; if a student did the practice required, it was assumed they were competent. This is in direct contrast to the CBE approach introduced after 1993, where students were required to demonstrate competence

before successfully completing the degree. CBE is outcome-focused, requiring the measurement of adequate performance in the workplace. CBE is defined as education for a prospective or actual role in society and focuses on demonstrated performance, de-emphasising time-based education and providing portability between practice contexts. It gained greater focus with the rise of behaviourist theories in the 1960s and 1970s,<sup>3</sup> and the development of CS or frameworks for use by different professional groups is one outcome of CBE. In 1989, the Australian Government embarked on a reform process for recognising overseas trained professionals and, less obviously, reform of professions, making them more prepared for future globalisation.<sup>4</sup> Dietetics was one of the first professions to develop CS,<sup>5</sup> and Australia was one of the first countries to have published CS for dietitians.<sup>1</sup>

CBE, however, remained controversial. Criticism was widespread in universities, partly because CBE had arisen in vocational education.<sup>4</sup> It was argued that competencies

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were reductionist and ignored the high level of knowledge required for professional practice. Alternatively, without assessment of individual performance in the workplace, aspects of professionalism and context-specific complexity were difficult to assert by purely testing knowledge.<sup>6</sup> Skills acquisition has been described as a complex interplay of knowledge, skills and attitudes and does not necessarily progress along a linear trajectory. Hodges<sup>6</sup> argues that competency is not a fixed entity; it changes over time and contexts. It may also be designed for one purpose but used for another.<sup>3</sup> Despite these limitations, CS and CBE are standard practice for all health professions in Australia<sup>4</sup> and are used in dietetics in Australia for both the examination of overseas candidates, as a basis for curriculum development and accreditation of programs,<sup>7–10</sup> and credentialing. Accreditation of education courses is a quality improvement process that uses CS as a basis for evaluating curriculum but does not necessarily take a CBE approach.<sup>11</sup> It can have a significant influence on training and thus professional practice. The accrediting body protects the profession from well-meaning but often misguided views about education but may also inadvertently restrict innovation.<sup>11</sup> The accrediting bodies, the professional community and educators need to have a shared understanding of CS, but this can be challenging, especially if the accrediting body holds power over the credentialing process.<sup>11</sup>

The aim of this research was to explore how a CBE framework influenced CS and their application and how this influenced dietetic practice in Australia since 1990.

## Methods

A qualitative investigation<sup>12</sup> was used to explore concepts of dietetic practice. Data analysed included all interviews that were previously undertaken with recent graduate dietitians during 1991 (n = 26), 1998 (n = 23) and 2007

(n = 19) and guided discussions (n = 7) conducted in 2014 with a variety of experienced and recent graduate dietitians and employers. These interviews and discussions were conducted as part of the development (1991) or review (1998, 2007, 2015) of the DAA CS. The methodology and ethics for the collection of the interview data have been previously published in 1993,<sup>13</sup> 1998,<sup>14</sup> 2007<sup>15</sup> and 2015,<sup>13</sup> but broadly, the methods used a mixture of functional analysis techniques and critical incident reflections to define the major work roles, key tasks and activities of the profession. Table 1 describes the demographics and methodology used in each of the studies.

Three experienced qualitative researchers, two of whom have had a significant stake in CS development and publication (SA, CP), re-analysed the original transcribed interviews with a view of constructing a narrative of how practice has changed over time and exploring the discourse of how competence was constructed. Only one researcher was previously involved in all the analyses. The third researcher had not been involved in any of the initial analyses, CS development or review and provided an independent view. Three transcripts from different time points were analysed by all three researchers to identify broad concepts emerging from the data, which were then independently summarised and discussed, and a coding framework describing broad themes was constructed. These discussions also supported researcher reflexivity in that individual interpretation was critically reviewed with peers and additional interpretations explored. The consistency of coding of these transcripts allowed the remaining transcripts to be allocated proportionately for analysis using the framework. Thematic analysis for data saturation was applied.<sup>12</sup> Themes were viewed within time frames and across the time frames (longitudinally) for all data collected using the coding framework. Quotes were used to illustrate each of the themes.

In addition, a content analysis of the DAA CS documents (1993,<sup>1</sup> 2009,<sup>16</sup> 2015<sup>2</sup>) was conducted by the first author to

**Table 1** Demographic information of dietitians interviewed, 1991–2014

Year	1991	1998	2007	2014
No. of participants (n)	26	23	19	28; 20 experienced, 8 recent graduate (focus groups) 67 (Delphi)
Years of practice (median & range)	0.25–1	0.5–1.5	0.75–2	<b>Focus group</b> Experienced 6–34 Recent graduate <1 <b>Delphi</b> 4–40
Sampling method Type of data collection	Purposive Critical incident interview	Purposive Description of core activities	Purposive Critical incident interview; Description of core activities	Iterative, multiple methods Guided discussion, Delphi questionnaire
Purpose of study	Validate original competency standards	Review existing competency standards	Review existing competency standards	Review existing competency standards; Validate revised competency standards

verify if the interview data identified themes over the same time period as the interviews. Accreditation Manuals/Standards<sup>7,8,10,17</sup> documents were also analysed to assist in the interpretation of and to triangulate the interview data and investigate how the CS were interpreted in curriculum design and practice placement as part of accreditation. This involved initial familiarisation with the content, followed by verification of themes identified in the interviews with these sets of documents. Particular attention was paid to themes identified in the interviews that were not reflected in either the CS or the Accreditation Manuals/Standards. The findings were used to assist interpretation of thematic analysis of the interview data and are therefore reported in the discussion.

## Results

Themes identified from interviews are followed by themes identified from the CS documents. A summary of the units or domains of practice in the National Competency Standards for Entry Level Dietitians is shown in Table 2. In 2015,<sup>2</sup> the words 'Entry Level' were removed from the title. Wording from Accreditation Manual/Standards was used to highlight themes from the interviews and how the interpretation of the accreditation process may have influenced the interpretation of the CS over time.

Four core themes emerged from the interviews: (i) communicating for better care, (ii) scientific enquiry for effective practice, (iii) critical thinking and evidence-based practice and (iv) professionalism. However, the contexts in

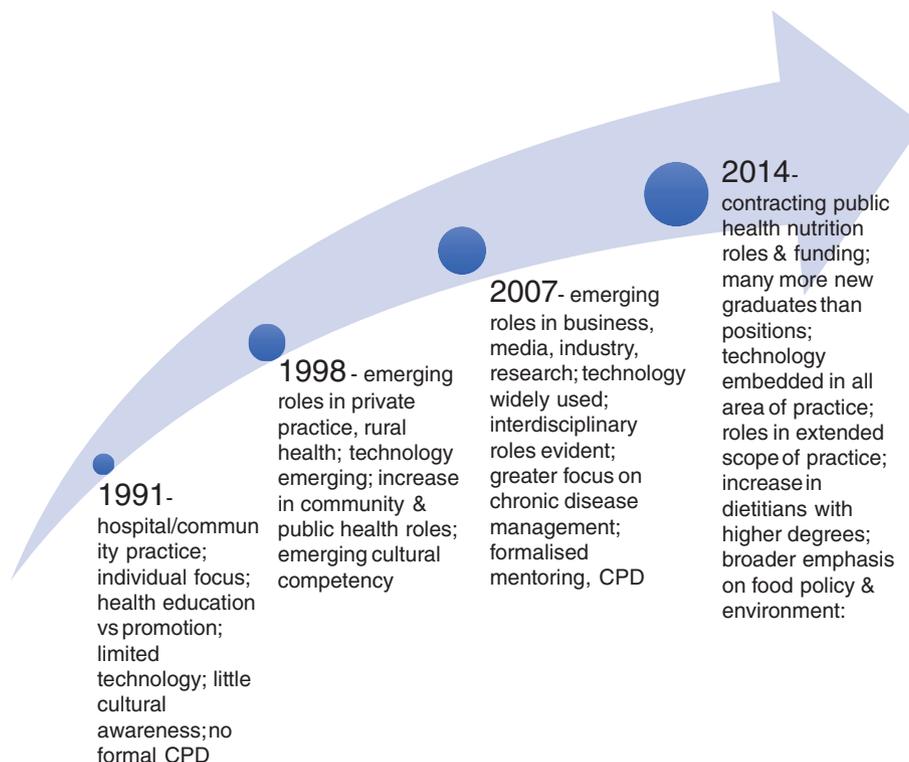
which dietitians were working changed dramatically between 1991 and 2017 (Figure 1). New themes of leadership, advocacy, entrepreneurship and business management became more prominent from 1998 but were ultimately grouped under professionalism in 2015 (Table 3).

**Communicating for better care**, as part of the therapeutic relationship, remained a central dietetic role. The communication skills of dietitians, however, evolved from educating patients (1991) to negotiating in partnership not only with patients/clients but with other stakeholders. The emergence of a social model rather than a medical model of health was evident, with more sophisticated methods of client engagement occurring.

*'Empowering a resident or client that we're seeing, or whether it is empowering the food service staff to adjust to new systems to essentially impact all residents, it's really the same thing'. (Focus group 4, 2014)*

The CS reflected the change in emphasis of this communication theme from 'Interprets and translates nutrition information' (1993)<sup>1</sup> to 'Collaborates broadly with clients and stakeholders' in 2015.<sup>2</sup>

**Scientific enquiry and problem-solving skills for effective practice, using the nutrition care process**, were central to dietetic practice over time. The key skills of assessing nutrition needs, planning and providing a nutrition intervention and evaluating outcomes were evident across all time points. As practice became more complex, this



**Figure 1** Emerging roles at each stage of the Competency Standards development and review.

approach extended to quality assurance, accessing funding and program planning.

*'I also need to be able to write proposals, whether that be program proposals or fee proposals to various bodies, ..., and that's part of ongoing funding, ..., and tender-writing, and things like that' (Tape 3, New graduate(NG), 2007)*

The CS reflect a shift in scientific enquiry from a data manager who 'Collects, organises and assesses data relating to the nutritional status of individuals and groups'<sup>1</sup> to a broad, outcome-focused practitioner with influence who 'Positively influences the health of individuals, groups and/or populations to influence positive outcomes'.<sup>2</sup>

**Critical thinking and evidence-based practice** became more dominant over time. The advent of computerised information in the mid 1990s and access to databases for quality assurance purposes, food analyses, online

professional journals and other information contributed to this. Interviewees in the 1990s expressed their frustration at not being able to access the correct information, whereas this had changed by 2007, where not finding the correct information would have been considered incompetent.

*'...lack of consultation would be incompetent. Not also using accurate nutrition information, so not looking at the literature or current guidelines to guide your nutrition messages'. (CI5, NG, 2007)*

Research enquiry in the CS of 1993 reflected the limited resources for practice-based research 'Demonstrates basic skills in research and evaluation',<sup>1</sup> which changed significantly by 2015 to 'Applies critical thinking and integrates evidence into practice'.<sup>2</sup>

**Professionalism** was a core theme throughout. Professional practice and personal development were listed as part

**Table 2** Main domains or units of competency, 1993–2015

1993	1998	2009	2015
Demonstrates knowledge sufficient to ensure safe practice	Underlying knowledge <i>Demonstrates knowledge sufficient to ensure safe practice</i>	Underlying knowledge	
Interprets and translates scientific knowledge and principles related to nutrition into practical information	Interpretation of nutritional information into lay language	Nutrition Communication	Collaborates with clients and stakeholders
Collects, organises and assesses data relating to the health and nutritional status of individuals and groups	Collection, analysis & assessment of nutrition & health data	Collection, analysis & assessment of nutrition & health data	
Manages nutrition care for individuals	Individual case management	Individual case management	Positively influences the health of individuals, groups and/or populations to achieve nutrition outcomes
Manages components of programs that deal with nutrition issues in the community as part of a health-care team	Population health	Community and Public Health Nutrition and Advocacy for Food Supply	
Influences and contributes to activities promoting a safe and nutritious food supply	Influencing food supply	Food Service Management	
Demonstrates basic skills in research and evaluation	Scientific approach	Research & Evaluation	Applies critical thinking and integrates evidence into practice
Demonstrates an organised, professional and ethical approach to work	Professionalism within organisation	Management & Organisation  Professionalism and Leadership	Practices professionally

**Table 3** Themes from Interviews

Themes	Domains of Competency			
	1993	1998	2009	2015
Communication for better care	Interprets and translates scientific knowledge and principles related to nutrition into practical information	Interpretation of nutritional information into lay language	Nutrition Communication	Collaborates with clients and stakeholders
	Manages nutrition care for individuals	Individual case management	Individual case management	Positively influences the health of individuals, groups and/or populations to achieve nutrition outcomes
	Manages components of programs that deal with nutrition issues in the community as part of a health-care team	Population health	Community and Public Health Nutrition and Advocacy for Food Supply	
Scientific enquiry for effective practice	Influences and contributes to activities promoting a safe and nutritious food supply	Influencing food supply	Food Service Management	
	Collects, organises and assesses data relating to the health and nutritional status of individuals and groups	Collection, analysis & assessment of nutrition& health data	Collection, analysis & assessment of nutrition& health data	Positively influences the health of individuals, groups and/or populations to achieve nutrition outcomes
Critical thinking and evidence-based practice	Demonstrates basic skills in research and evaluation	Scientific approach	Research & Evaluation	Applies critical thinking and integrates evidence into practice
Professionalism -Leadership and advocacy	Demonstrates an organised, professional and ethical approach to work	Professionalism within organisation	Professionalism and Leadership Management & Organisation	Practices professionally
Entrepreneurship and business management				

of the Core Competency Areas in 1991<sup>5</sup>; however, the concept of professionalism has changed. The emergence of cultural competency and the formalisation of continuing professional development and mentoring were evident from 1998.

*'The emphasis on the professionalism-type competencies need to be greater ... It should focus less on things that dietitians do, to actually function in a practice environment' (FG4, 2014).*

This theme was also reflected in all versions of the CS, changing from *'Demonstrates an organized, professional and ethical approach to work'*<sup>1</sup> to *'Practices professionally.'*<sup>2</sup>

Other themes that emerged more strongly over time and are listed below were eventually grouped under professionalism in 2015 (Table 3).

**Leadership and advocacy** has become more evident. Dietitians in 1991 saw their role in acute care as advocating for their professional status. In 1998, dietitians advocating for the patient emerged more strongly as a key task. In 2007, it was clear that a more systems-based approach was taken. In 2015, there was a return to a focus on where the profession sits amid a plethora of competing demands in the workplace. The emergence of access to online information by members of the community, together with conflict over which work roles were valued within the profession, posed a risk to professional credibility. Dietitians were no

longer seen as the first point of contact for nutrition information.

*'We're not really seen as the experts all the time, because there's all this online stuff ....., no one wants to listen to me, because they've read something online that they think is more credible'. (Focus Group 2, NG, 2014)*

In contrast, this was also viewed as an opportunity to move away from traditional patient care to other roles in the community, including the online community and other settings in which dietitians had not been traditionally employed. This was occurring as early as 1998.

*'I also do web development as well, so I've got a website up and running...Just general communications, making sure, you know, advertising gets out...trying to reach people' (Tape 17, NG, 1998)*

The need for CS to keep up with these social changes was reported to be essential.

The 2009 CS<sup>16</sup> include the added words around advocacy in the domain, *'Demonstrates professional, organised and ethical approach..., advocating for excellence in nutrition and dietetics'*; however, in 2015, this is assumed in the body or elements of the CS, with words such as *'positively influences', 'builds capacity' and 'actively promotes,* under *'Collaborates with clients and stakeholders.'*<sup>2</sup>

**Entrepreneurship and business management** emerged as more dietitians graduated, and traditional employment avenues decreased. The scope of dietetic practice has expanded from being largely in acute care, hospital-based community dietetics or small private practice in 1991, with emerging health promotion roles in 1998, including employment in government public health organisations, non-government organisations, food industry and research. From 1998, graduates still reported having mainly individual client care within their working portfolio, but the data showed there was scope to broaden this using marketing and other entrepreneurial skills.

*'... while we don't make a profit, we do actually have to run at cost price..., so sometimes we can get funding from third parties, for example, the Outback Division. Other times, places like AMS, so, Aboriginal Medical Services, pay for our time or, ..., other things. So it all sort of needs to be negotiated, which can sometimes be quite frustrating' (Tape 3, NG, 2007).*

The 2009 CS<sup>16</sup> included a separate domain on business and management skills reflecting this theme; however, it was subsumed into mainstream practice and incorporated into the *'Practices professionally'* domain in 2015.<sup>2</sup>

The emergence of multidisciplinary teams initially provided a clearer role for the dietitian as part of an allied health discipline. However, as scope of practice changed for all health disciplines, this also provided challenges.

*'I think the job market is changing, ...there's been a lot of cuts and they're not employing more dietitians, so we have to*

*branch out into other work areas... we're working more broadly than in just that clinical area now'. (Focus Group1, NG,2014)*

Frustrations were voiced across all data points about the way the practice placement program was organised, with a lack of understanding about the connection between placement experience and employability. There was also frustration expressed about the over-reliance on the acute hospital setting experience.

*'I was being pushed into a clinical area when I didn't really want to go into a clinical area... They wouldn't let me have a placement in private practice, even though I lined it all up and I suppose I always had problems with that' (Tape 22, NG, 1998).*

The Accreditation documents prescribe placement requirements and have done so since inception. Despite a competency framework suggesting that competence is not time-dependent, the requirement for 100 days of placement practice was retained through all versions and in keeping with international standards.<sup>18</sup> How these days are allocated was linked to the earlier versions of the CS, which clearly stated three domains of practice, individual medical nutrition therapy, food service management and community/public health nutrition. With the change in emphasis of the current CS,<sup>2</sup> these domains were given less emphasis in the current Accreditation Standards.<sup>10</sup>

*'The University must ensure the dietetics education program includes a Professional Placement Program, the duration of which must be a minimum of 100 equivalent working days' (Standard 5, p.10).*

All Accreditation Manuals included a section on Core Fields of Study up to 2015. These were based on the CS up to 2015, which included a unit or domain *'Demonstrates knowledge sufficient to ensure safe practice'* (Table 2). Increasing details of how to assess competence via range variables and evidence were included in 2006<sup>8</sup> but were removed in 2011 and published as a separate document for assessment purposes.<sup>19</sup> Subsequently, the concept was absorbed into the 2015 CS.<sup>2</sup>

The earliest Accreditation Manual<sup>7</sup> recognised the need for universities to retain their independence to innovate curriculum as practice evolved.

*'The nature of many jobs in public and private industries is undergoing change ... a trend to flexibility and versatility underlies this change. ... It is desirable that the profession develops ... with a common core of training and a broad common vocational purpose' (Section 2, p.1).<sup>7</sup>*

Accreditation Manuals continued to include a section on the philosophy of education for dietitians acknowledging the changes in the health-care environment; however, in the now renamed Accreditation Standards,<sup>10</sup> this has been replaced with a governance section, heralding a more

regulatory approach. A series of standards must now be met, which detail:

*'the minimum requirements that Universities need to demonstrate to gain accreditation for their Dietetics education program(s) and that Universities must continue to meet to maintain their accreditation' (Introduction p.4, 2017).*<sup>10</sup>

The 2014 interviews and focus groups asked participants to comment on the purpose and work roles of dietitians and whether they had issues with the current CS.

*'I think the real standout of being a dietitian is having that scientific background. It gives you that grounding to understand the role of food in health'. (FG 2, 2014)*

The requirement for dietitians to have prerequisite bio-science training appears in all accreditation documents. In the 2017<sup>10</sup> Standards, the specific timing and volume of chemistry, biochemistry, biology and physiology within the undergraduate curriculum is required.

*'Dietetics is the application of science in nutrition and dietetic practice, and its study is based on Human Biosciences and Food and Nutrition Science, taught within an evidence-based paradigm'. (Standard 4, p9)*

The application of medical nutrition therapy to individuals is a key feature in differentiating dietetics from nutrition. The 2011 Accreditation Manual,<sup>9</sup> in spelling out the key purpose of the profession of dietetics, also defines the difference between a dietitian and nutritionist.

*'The key difference between a dietitian and a nutritionist is that, in addition to or as part of their qualification in human nutrition, a dietitian has undertaken a course of study that has included substantial theory and supervised and assessed professional practice in medical nutrition therapy (individual case management) and food service management in addition to assessed and supervised professional practice in community and public health nutrition' (Section 1, p. 3).*

While this statement no longer forms part of the Accreditation Standards, it is clearly stated in the preamble to the 2015 CS.<sup>2</sup> The discussion weaves together these two sets of data.

## Discussion

The present study aimed to explore how a CS and CBE framework has transformed dietetic practice and culture in Australia from 1990 and what factors have influenced their interpretation. It found that (i) communicating for better care, (ii) scientific enquiry for effective practice, (iii) critical thinking and evidence-based practice and (iv) professionalism remained core to dietetic practice over time, but leadership, advocacy, business management and entrepreneurial skills have emerged more strongly as the scope of practice has diversified. The theme of professionalism, leadership and safe practice became much more

dominant, in line with generic competencies across the health domain.<sup>20</sup> The terminology of the CS suggests a greater sophistication and diversity of practice as time progressed (see Table 2). Throughout this time, however, generalist practice with stated domains in individual client care, food service management and program planning in community and public health was evident across all versions up till 2015. These domains were removed in the latest CS, which assumes that this generalist practice and preparatory education can be integrated and is reflected in the 2017 Accreditation Standards.<sup>10</sup>

The distinction between credentialing, competency and capabilities, where qualifications define the scope of practice of an allied health practitioner (credentialing), whereas the knowledge and skills required to perform in the workplace (competency) will reflect that particular workplace context, has been clearly articulated.<sup>21</sup> Credentialing requires a minimum standard of practice, and in the past, the DAA CS have been used in this way for accreditation. Greater understanding of the dynamic nature of practice has meant that the words 'entry level' have been removed from the 2015 CS, indicating that the CS are not minimum standards but reflect a continuum of practice.<sup>13</sup> Nonetheless, Accreditation Standards continue to influence how competency is interpreted and assessed in curricula.

National registration of health professionals in Australia has embodied a flexible but quality and safety focus, reflecting the increasing complexity of health practice and workforce requirements.<sup>22</sup> There has been a liberal approach to health profession education and little government regulation of entry points to professional programs. Universities must negotiate practice placements with brokers affiliated with health service providers, often at a cost. Demand-driven policy in universities has allowed large intakes of students who continue to have an interest in nutrition and dietetics. Nutrition and dietetics academics have struggled to provide the practice placements a CBE approach might dictate because the full cost of this is not covered by the university fees. How CS were applied in curriculum and the power held by DAA's Australian Dietetic Council (ADC) to withhold accreditation status and thus entry into the professional association increased as dietetic education programs proliferated.

The earliest versions of the Accreditation Manual did not specify resources required to conduct programs nor did it specify how placements would be conducted or assessed but rather held a view, perhaps naïve in retrospect, that academic independence was paramount.

Course directors of dietetic programs up until the 1990s were medical nutritionists or biochemists rather than academic dietitians. The expansion of the profession and the proliferation of dietetic programs saw the emergence of dietitian educators with higher qualifications in control of the curriculum and with increasing expertise in clinical education research and CBE. Despite this, the curriculum remained committed to the evidence-based medical model and its underlying scientific paradigm. The rules most clearly articulated in the Accreditation

documents revolve around the science required to practice as a dietitian and the number of days of practice placement.

Power<sup>23</sup> argues that dietitians using the medical model have little real influence relatively and have thus promoted a positivist, reductionist model of medical nutrition knowledge. This sets them up as the nutrition experts against the embodied knowledge of patients and clients. Clinging to knowledge informed by the rationalist medical model and scientific paradigm may therefore have unexpected negative consequences.<sup>24</sup>

Professional identity remained a key theme, described by participants in 2014 as the emergence of online 'fake' practitioners. They expressed their frustration: that as the experts in nutrition, they were not being given the same credence as nutritionists with limited training. On the other hand, they commented that acute care clinicians were rated more highly within the profession, a type of professional hierarchy that was unhelpful when there was so much work to be done in the wider community. There are opportunities for the profession to look more broadly at the links between nutrition science and dietetics, embracing some of the ideas suggested recently in Great Britain, where the two professions join in partnership.<sup>25</sup> Leadership and advocacy continue to be strong themes in Australian dietetic practice and have now been clearly articulated between proficient and advanced practice.<sup>26</sup>

The landscape in which dietitians practice showed increasing complexity, and clear boundaries separating professional roles were disappearing. Despite this, the data supported the notion that dietitians are scientists who understand the role of food in health and use evidence to provide food as a medical nutrition therapy. This understanding and evidence is increasingly applied to policy.<sup>27</sup> What appeared to be missing was a focus on other forms of evidence to better understand how individuals view nutrition and food in a world of ready access to the internet for consumers and social media to spread unscientific information.

The 2015 CS and the 2017 Accreditation Standards highlighted that competency remains a shifting construct and that professional behaviours change depending on economic and political reasons in the play of power. In publishing the current Accreditation Standards<sup>10</sup> and evidence guide,<sup>17</sup> the ADC, as the dietetic profession's accrediting body, has responded to the 2015 CS,<sup>2</sup> removing some barriers such as the domains of practice placement but not the time required for placement, which a true CBE approach would suggest. Other conditions of accreditation, such as the underpinning bio-science requirements, remain as a safeguard to the modern definition of dietetics and in keeping with international standards.<sup>28</sup> Current limits on courses via the Accreditation Standards may also reflect political pressure in gaining health professional registration. These limits may constrain innovations educators wish to introduce, with an eye on future changes in the health workforce.

Lukes describes power as three dimensional: those who have the authority to make the rules; the rules that

subordinates choose to follow; and contestable power, which is where those following the rules contest their viability.<sup>29</sup> He suggests that having power means being able to resist it as well as use it. Thus, the three-way dialogue between the profession, educators and accrediting bodies potentially becomes a contested space. Hodges suggests that competency will always be affected by different and dominant discourses, but the centrality of context and the importance of multidimensional thinking remain essential in understanding its interpretation.<sup>6</sup>

A profession's role is to reflect practice but also envision how that practice may evolve. Educators then need to translate that vision into needed competencies via an educational plan. The accreditors' roles are to uphold, to the profession and its stakeholders, what is needed in quality preparation.<sup>11</sup> The challenge is for the accrediting body to promote not just quality assurance but, more importantly, quality improvement. This can only occur when there is a true partnership and dialogue that includes all three stakeholders.

The strengths of this research include the triangulation of data from interviews and documents of the CS with Accreditation Manuals/Standards over a 25-year time period. It provides insight into how emphasis may change when a CBE framework is applied in practice. Limitations may include the authors' previous experience with the data and analysis, which may have introduced some bias. Every attempt was made to acknowledge this through researcher reflexivity. Further research involving the application of CS to curriculum and accreditation processes and how these manifest to improve the quality of the profession and ensure client and community safety is recommended.

Our research has identified different issues influencing dietetic practice in Australia. The influence of CBE has promoted an outcome learner focus from 1993 onwards, and the research behind each review of the CS has provided rich data to describe changes in the working and professional lives of dietitians over that time period. CBE continues to influence curriculum and particularly assessment and accreditation policy. Dietetics, although a small profession, has continued to remain dynamic despite restrictions in public sector employment, contributing to the profession growing and remaining sustainable. Accreditation policy and current standards have successfully maintained a standard of dietetic practice across a diverse country but have the potential to constrain innovation. The CS provide a framework for the interpretation of practice, and the rigorous review of CS over time using methodology to provide a voice for practicing dietitians is recommended. Further exploration of the culture of the profession into the future as the role becomes more diverse and less medicalised is warranted.

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## Conflict of interest

The authors have no conflicts of interest to declare.

## Authorship

Susan Ash collected and analysed the data and wrote the manuscript. Claire Palermo and Danielle Gallegos analysed the data and participated in writing and revising the manuscript.

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## ORIGINAL RESEARCH

# Dietetics workforce preparation and preparedness in Australia: A systematic mapping review to inform future dietetics education research

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### Abstract

**Aim:** The present study aimed to systematically map and summarise existing research regarding dietetics workforce preparation and preparedness that has been conducted in Australia. The secondary aim was to then identify gaps in the literature to inform future priority areas in Australian dietetics education research.

**Methods:** The databases MEDLINE, CINAHL, Embase, ERIC, Informit and PsycINFO were systematically searched from inception until July 2017 using key search terms to identify eligible studies. Extracted data were independently reviewed, and study quality was appraised by multiple researchers. Results were categorised by setting and primary focus/foci and then narratively summarised.

**Results:** Sixty-eight studies were included from 3779 records identified. Dietetics education research in Australia has spanned almost 30 years with more than half of studies (51%; 35/68) published in the last five years. The greatest proportion of research was conducted in the university setting (43%; 29/68), with students as participants (48%; 43/90) and was focused on the medical nutrition therapy area of dietetics practice (43%; 29/68). Published studies involving graduates (14%; 13/90); conducted in the workplace (12%; 8/68); and regarding emerging areas of dietetics practice (0%; 0/90) are lacking. Employment outcomes of dietetics graduates across Australia were last published over 25 years ago.

**Conclusions:** This review provides a map for dietetics educators and researchers in Australia to guide future research regarding the preparation and preparedness of dietitians. Advancing the Australian dietetics workforce of the future will require a strategic, coordinated and collaborative approach to address the research gaps identified in this review.

**Key words:** dietetics education, graduates, review, students, university, workforce.

### Introduction

An effective dietetics workforce has the potential to greatly impact and optimise the nutritional health of individuals, groups and populations. The Australian dietetics profession has been responsive to evolving workforce needs with periodic reviews of national competency standards.<sup>1</sup> However, strategic and ongoing research is essential to ensure that dietitians have been optimally prepared to practise in the

contemporary healthcare environment. With calls to change the way in which dietitians are prepared for practice in Australia,<sup>2,3</sup> an examination of the Australian scholarship regarding dietetics workforce preparation and preparedness is warranted.

Dietetics workforce preparation (also referred to as dietetics education) has been described as the formal process of equipping students with the requisite attributes to independently practise as a dietitian.<sup>4</sup> In Australia, accredited dietetics education programs are required by national accreditation standards to develop student competence through a range of activities which typically take place in universities and professional placement sites.<sup>5,6</sup> The 2015 revision of the National Competency Standards for Dietitians moved away from preparing graduates for certain settings and areas of practice (e.g. food service management (FSM)) with a greater emphasis on the development of professional attributes that can be applied in any setting.<sup>1,5</sup> Preparedness, a phenomenon that follows workforce

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preparation, may be referred to as that state of readiness of a dietetics student or graduate for practice and subsequent entry into the workforce. While this phenomenon has been investigated in other health professions such as medicine, pharmacy and nursing,<sup>7-9</sup> the preparedness of students/graduates for dietetics practice has not been systematically evaluated.

Enhancing the preparation and preparedness of future dietitians requires an analysis of robust data regarding the past, current and projected future state of the workforce. However, in Australia there is a lack of such information.<sup>10,11</sup> Despite this, the Dietitians Association of Australia (DAA) has suggested that both the dietetics workforce<sup>12</sup> and the dietetics education sector<sup>13</sup> have experienced significant growth and change in recent years. It has also been proposed that private practice and food industry are new and emerging areas of dietetics practice.<sup>1</sup> Further, in 2015 it was estimated that with approximately 600 dietetics graduates entering the workforce each year, the profession in Australia was growing at around 10% annually.<sup>11</sup> Given this apparent expansion and evolution, a parallel increase in dietetics research would be expected but is yet to be investigated.

Mapping reviews are designed to produce a 'map' of existing research by identifying and categorising literature from an established body of scholarship. While mapping reviews are not always systematic in their approach and do not aim to answer questions regarding the effectiveness of interventions, they typically characterise the volume and quality of literature on a topic. Their results can highlight gaps in the literature, inform future research priority areas and provide health professional educators with direction on their research and education activities.<sup>14,15</sup> Such reviews have been beneficial in providing guidance for academic and educational activities in other health professions including occupational therapy and medicine.<sup>16-19</sup> Despite the existence of an increasingly vast body of health professions' education literature,<sup>20</sup> profession-specific education research can be used to better prepare students to address future challenges.<sup>21</sup>

Optimising dietetics education and the future dietitians involved in this phenomenon requires a coordinated, strategic approach to research regarding dietetics workforce preparation and preparedness. Results of such an approach have the potential to identify gaps and guide future dietetics education research, and to enhance effective dietetics workforce development. This review aims to systematically map and summarise existing research regarding dietetics workforce preparation and preparedness that has been conducted in Australia. The secondary aim of this review is to then identify gaps in the literature to inform future priority areas in Australian dietetics education research. This review will help to progress dietetics workforce development and enhance the effectiveness of future dietetics education and practice in Australia.

## Methods

This review follows the format recommended in the Preferred Reporting Items for Systematic Reviews and Meta-

Analysis, the PRISMA statement,<sup>22</sup> and was guided by an *a priori* protocol developed to ensure methodological transparency. As mapping reviews are outside the scope of the International Prospective Register of Systematic Reviews (PROSPERO) requirements<sup>23,24</sup> this review was not registered. Ethical approval was not required.

The search strategy was developed based on the review's aim, the PICO tool (Population, Intervention/exposure, Comparison, and Outcome)<sup>25</sup> and author consensus, and was refined with the assistance of a health sciences librarian to optimise retrieval of relevant studies. A comprehensive and systematic search of the electronic databases MEDLINE (Ovid), CINAHL, Embase, ERIC, Informit and PsycINFO (Ovid) was conducted from inception to July 2017. No date or language limits were set. Reference lists of eligible studies were hand searched including issues of key journals published since July 2017 until December 2017 to identify any other eligible studies. The basic search strategy was adapted for use across the different electronic databases listed (Table S1, Supporting Information).

Studies were eligible for inclusion if they: (i) investigated or described an aspect of dietetics workforce preparation and/or dietetics workforce preparedness; (ii) involved participants who were key stakeholders in dietetics workforce preparation (i.e. dietetics students, graduates, educators, practice educators/supervisors/clinical educators/preceptors, and patients/clients involved in dietetics workforce preparation/preparedness); and (iii) were conducted in Australia or in relation to an aspect of dietetics workforce preparation and/or preparedness in Australia. Parameters for the phenomena of dietetics workforce preparation and preparedness were conceptualised within the curve of improving performance in healthcare as described by Khan,<sup>26</sup> whereby students generally enter university as 'incompetent' and they progress through a series of stages to emerge as 'competent' graduates who proceed towards becoming 'proficient' in the workplace. Studies reporting on the preparation and/or preparedness of dietitians together with other health professionals (e.g. dietetics and physiotherapy students) were excluded, as were studies that investigated or described the development of competency standards for dietitians in Australia. Only original research studies were included. Editorials, review articles, commentaries/opinion articles, letters and conference abstracts were not eligible for inclusion.

All records identified by the search were exported into EndNote (Version 8) and duplicates were removed. Articles were reviewed for relevance against the pre-determined inclusion/exclusion criteria via the title, abstract and author address (KM), and independently cross-checked by a second (RH) and third researcher (JK). Full-text records that appeared to be eligible for inclusion were retrieved and reviewed (KM), and independently cross-checked by a second researcher (JK). Researchers then compared results to ensure consistency and identify the level of agreement. Another researcher (DR) resolved disagreements by independently examining disputed studies and discussing with other researchers until consensus was reached. One

researcher (KM) reviewed the reference lists of eligible articles and recently published key journals to identify additional relevant studies.

A data extraction tool was developed with fields designed to capture key characteristics of included studies. Data which were relevant to the study's citation, design, participants, intervention (aspects of dietetics workforce preparation/preparedness investigated), context (setting and state) and practice area (area of dietetics practice) were systematically extracted into evidence tables. Categorisation of dietetics practice areas was guided by terms and descriptors used in national accreditation and competency standards.<sup>6,27</sup> Despite the removal of practice areas from the most recent competency standards, current accreditation standards for dietetics education programs in Australia state that in the professional placement program, students should be able to demonstrate competence in medical nutrition therapy (MNT), food service and public health nutrition.<sup>6</sup> In regard to the intervention or aspects being investigated, the primary focus/foci of each study were deemed by researchers as being in either one or more of the following six categories—activity (curriculum/place-ment/workplace), assessment, competency development, stakeholder attributes, stakeholder views and other. Extracting data into evidence tables was conducted by one researcher (KM), reviewed by a second researcher (JK) and disputes were resolved via a third researcher (DR).

The quality assessment tool developed by Hawker<sup>28</sup> designed for systematically appraising disparate studies, was used to assess the quality of included studies. Each study was assessed by two independent reviewers (KM, JK). Any disagreements were resolved through discussion with a third researcher (DR). The quality of each study was critically appraised using a pre-determined set of questions in which nine aspects of each study was assessed as either good, fair, poor or very poor.<sup>28</sup> Quality appraisal results were combined and presented in graphical form to summarise the quality of the cumulative evidence.

Due to the heterogeneous nature and variation of included studies' designs, a meta-analysis and/or a thematic synthesis was not appropriate nor was it in line with the review's aim. In accordance with Grant and Booth's description of a systematic mapping review,<sup>14</sup> the content from included studies was collated to enable a descriptive analysis and summary of the existing literature. Where studies included multiple aspects (e.g. assessment and competency development) or multiple populations (e.g. students and graduates), the total number of characteristics were tallied which meant there could be more characteristics than there were included studies. Pooled study characteristics were represented in both graphical and tabular form, and frequencies were narratively described. Studies were categorised into one of three settings of interest (i.e. university, placement and workplace). The different aspects being investigated (primary focus/foci) in each study were then plotted against a grid to enable comparison across the three settings and relative proportions narratively summarised.

## Results

A total of 68 studies met the inclusion criteria and were included in this review.<sup>3,11,29–94</sup> Fifty-seven studies were identified from the search of 3779 records (Figure 1) with an additional 11 studies identified through hand searching.

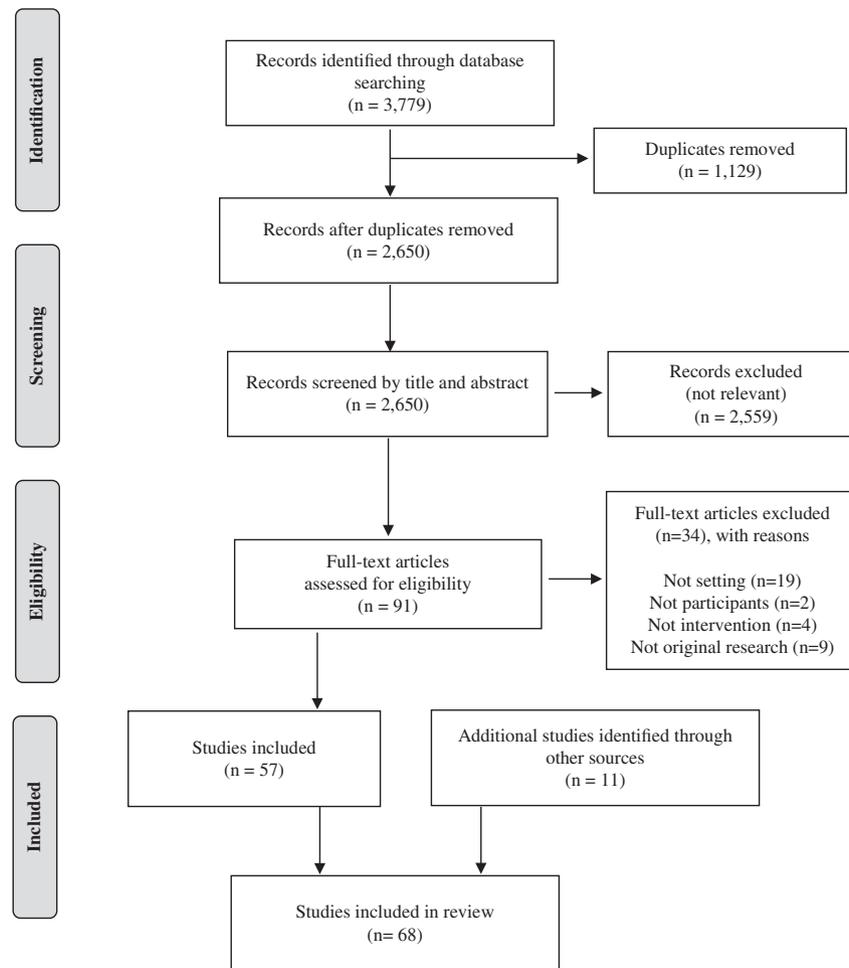
Published dietetics education research in Australia has spanned almost 30 years with the earliest study published in 1990. More than half (51%; 35/68) of the studies were published in the last five years (2013–2017 inclusive) and more than three-quarters (77%; 52/68) were published since 2009 (Figure S1).

The pooled characteristics of all studies included in this review are shown in Figure 2 and full characteristics for each study are shown in Table S2. The use of multiple different participant groups was employed by 26% of studies (18/68) resulting in a total of 90 participant groups across all studies. Students were the most frequently studied participants (48%; 43/90) while only one study (1%; 1/90) sampled employers of recent graduates and only 14% (13/90) involved graduates themselves. A total of 95 instances of data collection from seven different data collection methods were used across the 68 studies. Nearly one-third of studies (28%; 19/68) used a combination of these data collection methods with surveys (40%; 38/95) being the predominant method of collecting data.

In regard to the area of dietetics practice that studies focused on, the largest proportion of studies were solely focused on MNT (43%; 29/68) while only one study focused on the area of research (1%; 1/68). Almost two-thirds (65%; 44/68) of studies focused on either one or more of the practice areas of MNT, community and/or public health nutrition (CPHN) and FSM. No studies were specifically focused on the emerging areas of private practice or the food industry.

Six studies (6/68; 9%) were conducted across multiple states/territories of Australia, with research being conducted in the six different states/territories a total of 91 times across the 68 studies. Queensland and Victoria were the states in which the most research was conducted (both 33%; 30/91) followed by New South Wales (12%; 11/91).

Figure 3 shows the aspect of dietetics workforce preparation and/or preparedness (primary focus/foci) being investigated by all studies across each of the three settings (i.e. university, placement, workplace) and across multiple settings (e.g. university and placement). A total of 180 aspects were investigated across the 68 studies, as shown in Table S2. Compared to the university (43%; 29/68) and placement (38%; 26/68) settings, a relatively small proportion of research has been conducted in the workplace setting (12%; 8/68) (Figure 3). The number of studies that investigated attributes of stakeholders in the workplace (e.g. graduates and their employers) are also limited (2%; 3/180). The 'Other' aspects investigated in the workplace setting included mentoring (2%; 3/180) and graduate employment outcomes (2%; 3/180). Research reporting on the employment outcomes from a national sample of dietetics graduates in Australia was last published



**Figure 1** PRISMA flow chart describing the process of study selection.

in 1991. In regard to research reporting on the views of stakeholders, these were frequently investigated in the university and placement settings (e.g. students, practice educators) compared to the views of stakeholders in the workplace setting (e.g. graduates and employers of graduates) which were less commonly reported.

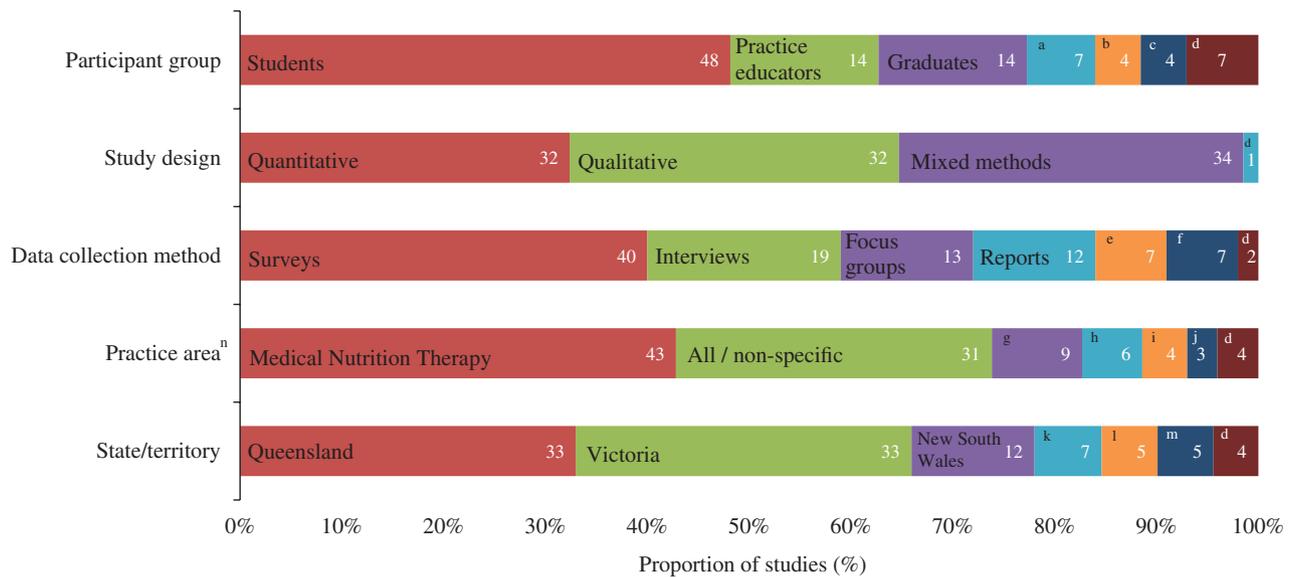
Quality appraisal of the research (Figure S2) indicated that the Introduction and Aims were well articulated across studies and therefore commonly rated as 'good' using the chosen tool. However, many papers (25%; 17/68) showed 'poor' or 'very poor' ratings when ethics and bias were considered. While these elements may have been present but not reported in the studies, it could also mean that collectively, the research lacked ethical rigour and may have been influenced by researcher bias.

## Discussion

This systematic mapping review provides the first broad examination of the scholarship conducted in Australia regarding the preparation and preparedness of the dietetics workforce. It demonstrates that research on this topic has been increasing in line with the reported expansion of the dietetics workforce and the dietetics education sector across

the country.<sup>12,13</sup> With a total of 68 studies included in this review, a country-specific body of evidence for dietetics education in Australia exists. However, there appears to be a relative overrepresentation of research from some settings (i.e. universities), participants (i.e. students) and areas of practice (i.e. MNT). Research in certain settings (e.g. workplaces), on certain participants (e.g. graduates) and in regard to emerging areas of dietetics practice (e.g. private practice and food industry) is lacking.

The findings that a relatively small proportion of research has been conducted in the workplace and has involved graduates and employers are noteworthy. Further analysis regarding the aspects of dietetics workforce preparation/preparedness investigated in the workplace setting reveal that there is a gap in published research on: the attributes of graduates (e.g. age, gender, state of graduation); graduate professional development activities (e.g. mentoring) and graduate employment outcomes (e.g. status of employment, time taken to secure work, area of practice). The finding that employment outcomes of dietetics graduates across Australia were last reported over 25 years ago is concerning. This indicates a gap in our ability to discern the effectiveness of dietetics education in meeting the needs of our dynamic and evolving workforce. This evidence gap



**Figure 2** Pooled characteristics of studies regarding dietetics workforce preparation and preparedness in Australia.

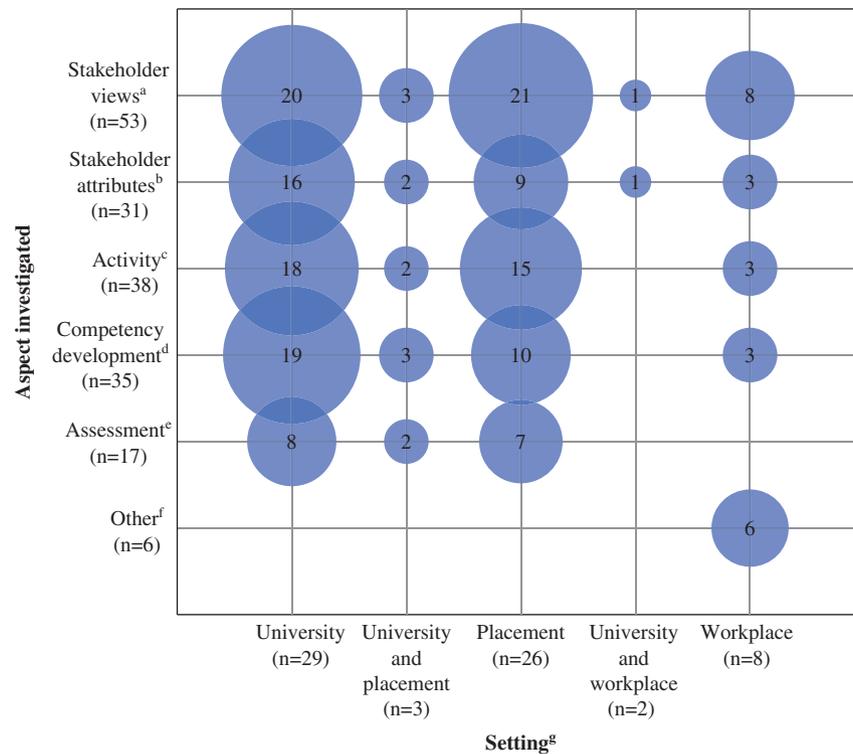
<sup>a</sup>Academic educators; <sup>b</sup>practitioners; <sup>c</sup>clients; <sup>d</sup>other; <sup>e</sup>document analysis; <sup>f</sup>discussion; <sup>g</sup>community and/or public health nutrition; <sup>h</sup>medical nutrition therapy, community and/or public health nutrition and food service management; <sup>i</sup>medical nutrition therapy and community and/or public health nutrition; <sup>j</sup>food service management; <sup>k</sup>South Australia; <sup>l</sup>Western Australia; <sup>m</sup>Australian Capital Territory; <sup>n</sup>medical nutrition therapy: includes activities related to the management of nutrition care for individuals, clients and/or patients; community and/or public health nutrition: includes activities related to the planning, implementation and evaluation of nutrition programs with groups, communities or populations; food service management: includes activities related to managing components of a food service system to nutritionally dependent and/or vulnerable populations; all: no single area of dietetics practice specified; includes activities that could be related to all areas of dietetics practice.

may reflect methodological challenges associated with contacting recent graduates once they have completed their university qualification, and their employers.<sup>95</sup> Further, given the apparent oversupply of dietetics graduates in Australia,<sup>10</sup> it may be of lower priority for academic educators to conduct research on students who have graduated from their programs, and/or graduates may be less willing to participate in research. In the USA, university programs are required by accreditation standards to set goals on graduate employment rates and employer satisfaction.<sup>96</sup> However, this is not a requirement for universities in Australia. In addition, universities may be collecting this data but not making it publicly available. As a self-regulated profession, dietetics is unable to benefit from the comprehensive collection and dissemination of national health practitioner data conducted by the Australian Health Practitioner Regulation Agency which is afforded to other health professions including physiotherapy, occupational therapy and pharmacy.<sup>97</sup> These gaps demonstrate a critical need for research and dissemination activities that provide data and evidence regarding recent dietetics graduates, their views, their attributes and their entry, or attempts to enter, into the workforce.

Pooled study characteristics indicate that there is a relatively large number of studies that involve students as the participants and which pertain to the MNT area of dietetics practice. As most dietetics educators in Australia are required to attribute some proportion of their work

activities to research, and that most dietetics educators report having a practice/research specialisation in clinical dietetics,<sup>11</sup> these findings are not surprising. The accessibility of students while enrolled at university, and the incentive for educators to evaluate newly developed educational activities may also help to explain these results. There appear to be few published studies which have focused on academic dietetics educators in Australia, who have been recognised as pivotal influencers in dietetics workforce preparation in other countries.<sup>98,99</sup> A plausible reason for this is that academics are actively conducting research rather than being involved as participants. There is also a demonstrated need for research that involves those stakeholders who are receiving, or are impacted by, the service being provided by graduates (e.g. employers, clients). With the Australian Government's desire to ensure that universities continue to improve on outcomes for graduates and employers,<sup>95,100</sup> exploring these gaps will be increasingly important.

More than three quarters of dietetics education research has been conducted in the three states which offer the greatest number of dietetics education programs.<sup>101</sup> This is a likely reflection of the higher proportion of dietetics educators in those states conducting related research or due to those researchers having expertise in education research. The small proportion of dietetics education research which has been conducted across multiple states may indicate a lack of collaboration between dietetics education programs.



**Figure 3** Aspects of dietetics workforce preparation and/or preparedness investigated within different settings. <sup>a</sup>Views, opinions or insights expressed by any stakeholder/s in dietetics education regarding their experiences or observations (subjective); <sup>b</sup>an attribute, trait or characteristic of a stakeholder/s in dietetics workforce preparation that can be measured (objective); <sup>c</sup>an activity conducted in the university/placement/workplace setting regarding the preparation, preparedness and/or professional development of students and/or recent graduate dietitians for the workforce; <sup>d</sup>an activity that is aimed at measuring, investigating or developing the competence of dietetics students/graduates; <sup>e</sup>an activity that involves students being assessed on an aspect of professional competence as a part of a dietetics education program; <sup>f</sup>any other aspect of dietetics workforce preparation/preparedness that is investigated in the study but does not fall into one of the previous categories of aspects investigated; <sup>g</sup>results tallied along the X axis relate to single studies conducted in those settings. However, as most studies investigated multiple aspects some studies may be represented in the Y axis more than once.

Initiatives such as a recently established Community of Practice for Dietetics Educators in Australia<sup>102</sup> may be an effective mechanism for collaborative dietetics education research that capitalises on shared resources and addresses shared issues. This echoes previous calls for strong leadership and academic collaboration within the dietetics education sector for the benefit of both the existing and emerging dietetics profession.<sup>4</sup>

The finding that MNT, FSM and CPHN are the areas of dietetics practice where most studies have been focused, warrants further examination. This finding is logical given that the studies in this review have been pooled over a 27-year period and that these settings have historically been a focus in previous competency and accreditation standards for dietetics education programs in Australia.<sup>27,103</sup> While knowledge and skills developed in established practice areas (e.g. MNT) may be transferable to other practice areas (e.g. private practice), this is yet to be demonstrated. Also, given that today's dietetics graduates may be working in a range of contexts outside these established areas (e.g. food industry), further data and research is urgently needed to ensure that graduates are well prepared for a range of practice areas.

The demonstrated increase in published studies in recent years confirms the assumption that the volume of dietetics education research is growing along with the apparent expansion of both the dietetics education sector<sup>13</sup> and the dietetics workforce in Australia.<sup>12</sup> The 2009/2010 and 2014/2015 spikes in publications may be reflective of increased dietetics education scholarship associated with the most recent revisions of the national competency standards in Australia, which took place in 2009 and 2014/2015.<sup>1,104</sup> The peak of publications seen in 2014 may also have coincided with the surge in dietetics education programs in Australia.<sup>1</sup> In 2014, it was reported that 23 dietetics education programs (either accredited by or seeking accreditation from the DAA) were being offered by 18 Australian universities.<sup>11</sup> Along with a small reduction in accredited dietetics education programs since 2014 (in December 2017, 18 programs were being offered from 16 universities<sup>101</sup>) the volume of dietetics education research published each year appears to have decreased from 2014 to 2017. As the dietetics educator workforce continues to develop and evolve, it is reasonable to assume that research regarding dietetics workforce preparation and preparedness will stabilise, if not increase, in future years.

It is recognised that a significant amount of research conducted outside of Australia and regarding health professions other than dietetics can be used to inform the preparation and preparedness of dietitians in Australia. To address the review's aims, only research regarding workforce preparation and preparedness in Australia was considered. Due to the heterogeneous nature of the research methodologies of included studies (qualitative, quantitative and mixed methods) in this review, a quality appraisal tool was chosen to standardise the assessment. However, this may have unfairly biased the assessment of some studies which were not well-matched to the tool. For example, short reports and case studies were appraised in the same way as full, original research articles. Further, the ethical rigour aspects of the quality assessment tool required multiple criteria to be met for studies to be classified as 'good'. Also, studies published almost 30 years ago were appraised in the same way as studies published in 2017, despite significant advancements in the protocols, practices and guidelines which exist to guide research today. The categorisation of studies into areas of practice may not reflect the main areas of practice where dietitians in Australia currently work. Due to a lack of published data on current dietetics practice areas, efforts were made to align categories with areas described in Australian dietetics competency and accreditation standards. Also, researcher discretion was sometimes needed to interpret the related area of practice and aspect of dietetics workforce preparation being investigated in each study.

While the development of national competency standards is relevant to dietetics workforce preparation, studies focusing on this topic were excluded. This was in recognition of competency standards being applicable to the entire dietetics workforce (not just those being prepared for the workforce), the broader body of evidence used to inform competency standard development and that a review and description of competency standard development in Australia has previously been described.<sup>1,5,105</sup>

A synthesis of results which is characteristic of most systematic reviews (e.g. a meta-analysis of quantitative studies or a thematic synthesis of qualitative studies) was neither possible nor appropriate in this review. However, this review was methodologically enhanced by a systematic approach being taken to the search, appraisal and analysis of included studies. This is not typical of mapping reviews<sup>14</sup> but was carried out in order to enhance rigour. Multiple researchers were involved in all stages of the review, which was also strengthened through the development of an *a priori* protocol, predetermined data extraction tools and the development of consensus on any disputed results through iteration and researcher discussion.

This review has demonstrated that there are gaps in the research that currently exists regarding dietetics workforce preparation and preparedness in Australia. While ongoing research regarding these important phenomena and in this evolving workforce sector is required, the following categories and specific areas highlight existing gaps in scholarship, including:

- Participants: graduates, employers and academic educators
- Settings: workplaces
- Areas of practice: emerging areas such as private practice and food industry
- States/territories: multiple/combined states/territories

In addition, significant gaps exist regarding aspects of dietetics workforce preparation and preparedness that have been investigated in the workplace setting (i.e. attributes, views and activities of recent graduates in Australia). The development of a national database to profile dietetics graduate attributes in Australia may be a useful tool to enable: the dietetics profession to analyse trends in the emerging workforce; dietetics educators to plan and execute relevant curricula and activities; and dietetics students and graduates to manage their expectations regarding career choices and to make informed decisions on future career paths.

This systematic mapping review provides evidence of existing research regarding the preparation and preparedness of the dietetics workforce in Australia and can be used to guide dietetics educators and researchers in future research. While it is encouraging that a body of dietetics education research exists and has been increasing, if the Australian dietetics workforce of the future is to further advance the nutrition-related health of the population, a strategic, coordinated and collaborative approach is recommended to address the research gaps identified in this review.

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## Conflict of interest

There are no conflicts of interest to declare.

## Authorship

KM conceptualised the study with contributions from KC and RH. KM and JK screened, extracted and appraised the data. RH assisted with data screening. KM, JK, KC and DR participated in data interpretation. KM drafted the manuscript and all authors participated in revising the manuscript. All authors have read and approved the final version of the manuscript and declare that the content in the present study has not been published elsewhere. The authors would like to acknowledge Mr David Honeyman and Mrs Evelyne Rathbone for their assistance in searching for and presenting the data, respectively.

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## Supporting information

Additional Supporting Information may be found in the online version of this article at the publisher's web-site:

**Figure S1** Number of publications regarding dietetics workforce preparation and preparedness research in Australia by year. <sup>a</sup>Indicates year that study was first published (e.g. published online) which may differ from the issue year of the study.

**Figure S2** Pooled results of the quality appraisal using the tool described by Hawker<sup>28</sup> for all studies included in the review.

**Table S1** Full search strategy for identifying dietetics workforce preparation and/or preparedness research conducted in Australia.

**Table S2** Full characteristics of each study included in the review.

## ORIGINAL RESEARCH

## Complementary feeding: Attitudes, knowledge and practices of urban families in northern Thailand

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**Abstract**

**Aim:** Urban families in middle-income countries are currently facing cultural and lifestyle transition. Changing from an agricultural to an industrial society may affect family roles and child-care practices. The present study aims to reveal family attitudes, knowledge and practices focusing on complementary feeding (CF).

**Methods:** A cross-sectional study was conducted in three Child Health Clinics in Chiang Mai, Thailand. Self-administered questionnaires were given to families caring for healthy infants and children less than 18 months of age during October to November 2016.

**Results:** One-hundred and eight respondents completed questionnaires. The study found different attitudes and knowledge gaps between the respondents who were mothers and other family members ('others'). The 'others' were less likely to value CF as a crucial factor promoting child growth and development. Moreover, they had misperceptions about the benefits of animal-based protein and were less confident in their ability to feed the child properly. Most families reported timely introduction of complementary food, using proper milk products and encouraging age-appropriate feeding methods. However, there were undesirable practices including delaying introduction of animal-based protein, inadequate food diversity, the use of seasoning, feeding pre-masticated food and offering food as a reward.

**Conclusions:** These findings suggest that nutritional education should be extended to all caregivers involved in CF to improve the adherence to feeding recommendations.

**Key words:** caregiver, complementary feeding, parental attitudes, infants, Thai family, urban family.

**Introduction**

The period between conception and the end of the second year of life is regarded as a window of opportunity during which a variety of endogenous and exogenous factors can exert lasting effects on growth and developmental outcomes.<sup>1</sup> Nutrition is considered as one of the most important factors, with most research focusing on maternal nutrition and breastfeeding.<sup>1</sup> However, complementary feeding (CF) is also a crucial part of nutrition during the first 1000 days.<sup>1</sup>

Although the World Health Organisation (WHO) has provided international guidelines and programmes for infant and young child feeding (IYCF), there is a huge difference in implementation and practices between countries.<sup>2</sup> Apart from geographical and economic factors, CF is also influenced by cultural background, beliefs and knowledge of parents about appropriate practices.<sup>3</sup>

Thailand is classified by the World Bank as an upper-middle-income country.<sup>4</sup> It is currently facing a double burden of malnutrition, similar to many countries in Asia. Nowadays, stunting and wasting among young children persists but has declined in severity whereas overweight and obesity have increased rapidly.<sup>5,6</sup> According to the Thai National Health Examination Survey (NHES) 2014–2015, stunting and wasting was present in 5.7% and 5.6% of preschool-aged children, respectively, compared with 6.3% and 2.7% in the previous survey (NHES 2008–2009) while the prevalence of overweight and obesity increased from 8.5% to 11.3% in the latest survey.<sup>7,8</sup> In addition, micronutrient deficiency, particularly iron and zinc, remains a challenge. The evidence shows that 32.2–41.8% and 2.5–9.9% of pre-school aged children had iron deficiency and iron

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deficiency anaemia, respectively,<sup>9</sup> while 57% of school-aged children had zinc deficiency.<sup>10</sup>

Currently, poverty and unaffordability of food are less likely to be the main reasons for nutritional problems in Thai children.<sup>11,12</sup> On the other hand, nutrition education, access to accurate sources of health information and changing attitudes or lifestyles may be more likely causes. Urban families can be considered to represent the transitional situation in Thailand. In 1985, Knodel *et al.*<sup>13</sup> found that women who lived in urban areas had shorter breastfeeding duration and earlier introduction of complementary foods compared with national statistics. However, a recent survey of working mothers in Bangkok showed 78.6% of them exclusively breastfed for at least 3 months.<sup>14</sup> Although the breastfeeding rate has improved, it is unclear whether attitudes and knowledge about IYCF especially CF have also changed. The number of working mothers has tended to increase in urban families, hence other people (i.e. father, grandparents and babysitters) may act as caregivers and their attitudes and knowledge should also be evaluated. Recently, Thai CF guidelines have been launched to promote good practice in IYCF in Thailand (Appendix 1). However, it is likely that the success of the guidelines may be influenced by family context and attitudes about CF. Therefore, the present study was conducted in Chiang Mai, the most developed city in northern Thailand, to demonstrate attitudes, knowledge and current CF practices of mothers and other caregivers living in an urban area.

## Methods

This study has been reported in accordance with the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) statement. The cross-sectional study was conducted at Child Health Clinics (CHCs) of which two were tertiary hospitals and the other was a community facility. Data were collected during October to November 2016. Ethical approval was obtained from the Ethics committee of the Faculty of Medicine, Chiang Mai University (Ethical approval number PED-2559-04304). The self-administered questionnaire was given to the family at the time of visiting the clinics for routine immunisation as well as growth and development monitoring. The questionnaire was anonymous and contained no sensitive questions.

Families were included if their child was a term singleton, healthy and less than 18 months of age. The respondent could be the mother, father, grandparent or close relative involved in caring for and feeding the child. All respondents were asked to answer the questions related to their knowledge and attitudes, but only the respondents caring for infants aged 6–18 months were eligible to answer the questions on practical aspects of feeding. The questionnaires were anonymised and the respondents were identified by a study number. If the respondent was illiterate, other family members or health-care professionals were asked to help them complete the questionnaire.

For the purposes of this study, complementary foods were defined as ‘Any nutrient-containing food or liquids other than breast milk and infant formula’ as defined by the European Food Safety Authority and the European Society for Paediatric Gastroenterology, Hepatology, and Nutrition.<sup>15,16</sup>

According to the Thai National Guideline for CF,<sup>17</sup> caregivers should introduce the first, second and third main meal at 6, 8 and 9–12 months of age. In this context, a ‘main meal’ was defined by a combination of staple foods and other food groups to provide a majority of calories and nutrients each day.

The self-administered questionnaire was divided into four main parts. The first part included general information about the respondents and their children. The second part consisted of questions covering basic knowledge and attitudes regarding IYCF. The remaining two parts focused on practical and behavioural aspects of CF. Because responses were expected to differ according to the infant’s age, the study population was separated into three infant age groups based on published data<sup>18</sup> and followed the similar categories used in the recommendations from the Thai National guideline for CF (Appendix 1).<sup>17</sup> Infants who were 6–8, 9–12, and 13–18 months of age were classified as Group A, B and C, respectively.

Statistical analysis was performed using the IBM SPSS Statistics program (version 22.0; SPSS Inc., IBM Company, Chicago, IL, USA). Categorical variables were expressed as number and percentage while continuous variables were expressed as mean  $\pm$  SD or median (range) as indicated. Chi-squared or Fisher’s exact test was used for comparing categorical data while quantitative data were compared by Student’s *t*-test or Mann–Whitney *U*-test. A *P*-value of less than 0.05 was considered as statistically significant. If the respondents did not reply to all questions, the missing data were shown as ‘not answered’. The initial aim of this study was to explore attitudes, knowledge and practices related to CF in Thai urban families, enrolling all eligible families who attended the clinics during the study period. However, because the ratio of non-maternal caregivers was unexpectedly high, a post-hoc calculation was performed to estimate the effect size that could be determined comparing the non-maternal caregiver and maternal caregiver groups, based on the percentage of respondents who agreed that CF is an important factor promoting infant growth. When using 80% power and 0.05 significance level, the percentage difference between these groups was 28%.<sup>19</sup>

## Results

One-hundred and eight families were recruited to the study. All respondents answered the questions related to their knowledge and attitudes about CF while only 72 of them were eligible to answer the practical questions. All respondents were literate and answered the questionnaire by themselves. More than half of all respondents were the infant’s mother while 38% of them were another family member (‘others’) including father, grandparent and close

**Table 1** Demographic data of respondents and their children

Characteristic of respondent	All respondents (n = 108), number (%)	Mothers (n = 67), number (%)	Others (n = 41), number (%)	P-value <sup>(a)</sup>
<b>1. Relationship to infant/child</b>				
Mother	67 (62.0)	NA	NA	NA
Father	34 (31.5)			
Grandparent	6 (5.6)			
Other relative (i.e. aunt, uncle)	1 (0.9)			
<b>2. Primary caregiver<sup>(a)</sup></b>				
Mother	65 (60.2)	NA	NA	NA
Other	9 (8.4)			
<b>3. Age (years)</b>				
<20	4 (3.7)	3 (4.5)	1 (2.4)	<0.01
20–29	31 (28.7)	23 (34.3)	8 (19.5)	
30–39	63 (58.3)	37 (55.2)	26 (63.4)	
40–49	6 (5.6)	2 (3.0)	4 (9.8)	
≥50	2 (1.9)	0	2 (4.9)	
Not answered	2 (1.9)	2 (3.0)	0	
<b>4. Education</b>				
Primary school	2 (1.9)	0	2 (4.9)	0.539
Lower secondary school	11 (10.2)	7 (10.4)	4 (9.8)	
Higher secondary school	23 (21.3)	12 (17.9)	11 (26.8)	
Bachelor degree	51 (47.2)	32 (47.8)	19 (46.3)	
Postgraduate degree	20 (18.5)	15 (22.4)	5 (12.2)	
Not answered	1 (0.9)	1 (1.5)	0	
<b>5. Occupation</b>				
Housewife	26 (24.1)	25 (37.3)	1 (2.4)	<0.01
Farming and agriculture	1 (0.9)	0	1 (2.4)	
Government employee	21 (19.5)	9 (13.4)	12 (29.3)	
Other (private employee, self-employment)	59 (54.6)	33 (49.3)	26 (63.4)	
Not answered	1 (0.9)	0	1 (2.4)	
<b>6. Living in the city</b>				
	51 (47.2)	28 (41.8)	23 (56.1)	0.319
<b>7. Extended family</b>				
	62 (57.4)	40 (59.7)	22 (53.7)	0.568
<b>8. Family income (monthly, Baht)</b>				
<10 000	12 (11.1)	10 (14.9)	2 (4.9)	0.336
10 000–29 999	55 (50.9)	31 (46.3)	24 (58.5)	
30 000–49 999	35 (32.4)	22 (32.8)	13 (31.7)	
≥50 000	4 (3.7)	3 (4.5)	1 (2.4)	
Not answered	2 (1.9)	1 (1.5)	1 (2.4)	
<b>Characteristics of infant or child</b>				
<b>1. Gender, male</b>				
	54 (50.0)	36 (53.7)	18 (43.9)	0.666
<b>2. Age (months)</b>				
<6	36 (33.3)	19 (28.3)	17 (41.5)	0.609
6–8	23 (21.3)	15 (22.4)	8 (19.5)	
9–12	24 (22.2)	16 (23.9)	6 (14.6)	
>12	25 (23.2)	17 (25.4)	10 (24.4)	
<b>3. First born infant</b>				
	71 (65.7)	44 (65.7)	27 (65.9)	0.11

NA, not analysed.

<sup>(a)</sup> Fisher's exact test.

relatives who lived in the same home. Among all respondents, 60.2% were the self-defined primary caregiver. The most common age group was 30–39 years but the 'others' included significantly more seniors than the maternal group. In addition, 65% of all respondents were well educated, having at least a degree. According to the monthly income, most families would be classified as

middle class. Furthermore, there was a significantly higher ratio of housewives in the group of mothers compared with the 'others' ( $P < 0.01$ ). Among all respondents, nearly half lived inside the city and 53% lived in an extended family. The majority of infants and young children were first born, with equal proportions of boys and girls (Table 1).

**Table 2** Knowledge and attitudes related to complementary feeding

Topics	All respondents (n = 108)	Mother (n = 67)	Other respondents (n = 41)	P-value <sup>(a)</sup>
1. Timing of introducing complementary foods, number (%)				
<4 months	0	0	0	0.625 <sup>(b)</sup>
4– <6 months	12 (11.1)	5 (7.5)	7 (17.1)	
6 months	65 (60.2)	41 (61.2)	24 (58.5)	
>6 months	30 (27.8)	20 (29.8)	10 (24.4)	
Not answered	1 (0.9)	1 (1.5)	0	
2. Age at starting other main meals (months), median (range)				
Second meal	8 (5–12)	8 (5–10)	6 (6–12)	<b>0.040</b> <sup>(c)</sup>
Third meal	12 (8–12)	12 (8–12)	12 (8–12)	0.873 <sup>(c)</sup>
3. Is the animal-based protein different from plant-based protein? number (%)				
Yes	88 (81.5)	56 (83.6)	32 (78.0)	0.284 <sup>(b)</sup>
No	17 (15.7)	8 (11.9)	9 (22.0)	
Not answered	3 (2.8)	3 (4.5)	0	
4. What is/are the difference(s) between animal-based proteins compared to plant-based proteins? (Can choose more than one), number (%)				
More difficult to digest	57 (52.8)	36 (53.7)	21 (51.2)	0.679 <sup>(d)</sup>
Higher allergenicity	27 (25.0)	18 (26.9)	9 (21.9)	0.512 <sup>(d)</sup>
Higher cost	3 (2.8)	1 (1.5)	2 (4.9)	0.309 <sup>(d)</sup>
A better supply of essential amino acids	14 (13.0)	9 (13.4)	5 (12.2)	0.814 <sup>(d)</sup>
A good source of iron and zinc	18 (16.7)	15 (22.4)	3 (7.3)	<b>0.034</b> <sup>(d)</sup>
5. The most reliable source of information about infant and young children feeding is, number (%)				
Health-care professionals	55 (50.9)	35 (52.2)	20 (48.8)	0.643 <sup>(b)</sup>
Maternal and child handbook	10 (9.3)	5 (7.5)	5 (12.2)	0.516 <sup>(b)</sup>
Official website of the Ministry of Public Health	5 (4.6)	5 (7.5)	0	0.122 <sup>(b)</sup>
Maternal-child magazine	0	0	0	0.288 <sup>(b)</sup>
Other online information	5 (4.6)	4 (5.9)	1 (2.4)	0.180 <sup>(b)</sup>
Advice from seniors	3 (2.8)	1 (1.5)	2 (4.9)	0.491 <sup>(b)</sup>
Advice from peers	1 (0.9)	0	1 (2.4)	0.364 <sup>(b)</sup>
Not answered	29 (26.9)	17 (25.4)	12 (29.3)	0.288 <sup>(b)</sup>
6. How confident you are to feed your child properly? (1 = least, 6 = most), number (%)				
1	3 (2.8)	0	3 (7.3)	0.075 <sup>(b)</sup>
2	4 (3.7)	2 (3.0)	2 (4.9)	
3	13 (12.0)	4 (6.0)	9 (22.0)	
4	48 (44.4)	36 (53.7)	12 (29.3)	
5	19 (17.6)	13 (19.4)	6 (14.6)	
6	6 (5.6)	3 (4.5)	3 (7.3)	
Not answered	15 (13.9)	9 (13.4)	6 (14.6)	
7. What is/are the important factors that affect growth and development of children? (Can choose more than one), number (%)				
Exclusive breastfeeding until 6 months of age	89 (82.4)	57 (85.1)	32 (78.0)	0.211 <sup>(b)</sup>
Appropriate complementary feeding	74 (68.5)	51 (76.1)	23 (56.1)	0.017 <sup>(b)</sup>
Supplementation of vitamins and minerals	20 (18.5)	16 (23.9)	4 (9.8)	0.066 <sup>(b)</sup>
Intake of high quality infant formula	10 (9.3)	6 (8.9)	4 (9.8)	0.566 <sup>(b)</sup>
Other (i.e. nurture)	1 (0.9)	0	1 (2.4)	0.378 <sup>(b)</sup>

<sup>(a)</sup> P-value was calculated by comparison between mother and other respondent groups.

<sup>(b)</sup> Fisher's exact test.

<sup>(c)</sup> Mann-Whitney *U*-test.

<sup>(d)</sup> Chi-squared test.

As shown in Table 2, a majority of respondents stated ages for the optimal timing of introduction and for starting the second and third main meals that were consistent with the Thai National guideline.<sup>17</sup> However, for the second

main meal, the 'others' reported a significantly earlier age compared with the 'mothers' (6 months vs 8 months,  $P = 0.040$ ). Furthermore, the results showed most of the respondents considered that animal-based protein (ABP)

**Table 3** Infant and young child feeding (IYCF) practices among different age groups

Feeding practices	Group A, 6–8 months (n = 23)	Group B, 9–12 months (n = 24)	Group C, 13–18 months (n = 25)	P-value
1. Feeding practices related to milk intake				
Current milk intake, number (%)				
Breast milk (breastfeeding and expressed breast milk)	12 (52.2)	7 (29.2)	7 (28.0)	0.572 <sup>(a)</sup>
Combined breast milk and formula	3 (13.0)	6 (25.0)	5 (20.0)	
Infant or Follow-on formula	8 (34.8)	7 (29.2)	10 (40.0)	
Cow's milk	0	3 (12.5)	2 (8.0)	
Not answered	0	1 (4.2)	1 (4.0)	
Continue using breast milk along with complementary feeding, number (%)	15 (65.2)	13 (54.2)	12 (48.0)	0.718 <sup>(a)</sup>
Bottle feeding (expressed breast milk and formula), number (%)	19 (82.6)	13 (54.2)	16 (64.0)	0.320 <sup>(a)</sup>
2. Complementary feeding practices				
Timing of introducing complementary feeding, median age (range)	6 months (5–6)	6 months (3–7)	6 months (4–6)	0.610 <sup>(b)</sup>
Frequency of main meal, number (%)				
1	18 (78.3)	0	0	<0.001 <sup>(a)</sup>
2	3 (13.0)	6 (25.0)	5 (20.0)	
3	1 (4.3)	18 (75.0)	19 (76.0)	
≥4	0	0	1 (4.0)	
Not answered	1 (4.3)	0	0	
Type of first complementary foods introduced (more than one could be chosen), number (%)				
Rice porridge	13 (56.5)	15 (62.5)	16 (64.0)	0.288 <sup>(a)</sup>
Mashed banana	11 (47.8)	6 (25.0)	12 (48.0)	
Commercial infant food	4 (17.4)	4 (16.7)	0	
Fruit juice	1 (4.3)	0	0	
Other (i.e. pumpkin)	1 (4.3)	1 (4.2)	0	
Texture of current complementary foods (choose more than one), number (%)				
Soup	0	2 (8.3)	0	<0.001 <sup>(a)</sup>
Mashed food/ purée	19 (82.6)	6 (25.0)	3 (12.0)	
Chopped food	3 (13.0)	11 (45.8)	6 (24.0)	
Family food	0	5 (20.8)	16 (64.0)	
Timing of first introduction of animal-based protein, number (%)				
6–7 months	16 (69.6)	12 (50.0)	12 (48.0)	0.177 <sup>(a)</sup>
8–9 months	2 (8.7)	10 (41.7)	10 (40.0)	
10–12 months	NA	1 (4.2)	2 (8.0)	
>12 months	NA	1 (4.2)	0	
Not answered	1 (4.3)	0	1 (4.0)	
Type of first animal-based protein introduced (Can choose more than one), number (%)				
Egg yolk	16 (69.6)	19 (79.2)	17 (68.0)	0.303 <sup>(a)</sup>
Fish	6 (26.1)	6 (25.0)	7 (28.0)	
Liver	4 (17.4)	4 (16.7)	5 (20.0)	
Pork	4 (17.4)	6 (25.0)	1 (4.0)	
Whole eggs	3 (13.0)	2 (8.3)	5 (20.0)	
Chicken	2 (8.7)	3 (12.5)	1 (4.0)	
Beef	0	0	17 (68.0)	
Current food diversity, number (%)				
<4 food groups	14 (60.9)	8 (33.3)	10 (40.0)	0.196 <sup>(a)</sup>
≥4 food groups	8 (34.8)	14 (58.4)	15 (60.0)	
Not answered	1 (4.3)	2 (8.3)	0	
Frequency of snacks each day, number (%)				
None	18 (78.3)	8 (33.3)	8 (32.0)	0.008 <sup>(a)</sup>

**Table 3** Continued

Feeding practices	Group A, 6–8 months (n = 23)	Group B, 9–12 months (n = 24)	Group C, 13–18 months (n = 25)	P-value
1	4 (17.3)	12 (50.0)	12 (48.0)	
2	0	1 (4.2)	1 (4.0)	
≥3	0	0	0	
Not answered	1 (4.3)	3 (12.5)	4 (16.0)	
Daily intake of fruit juices, number (%)				
None	16 (69.6)	14 (58.3)	10 (40.0)	0.239 <sup>(a)</sup>
1–2 Oz	6 (26.1)	4 (16.7)	3 (12.0)	
3–4 Oz	0	1 (4.2)	5 (20.0)	
≥4 Oz	0	0	0	
Not answered	1 (4.3)	5 (20.8)	7 (28.0)	
Home cooking, number (%)				
Yes	21 (91.3)	22 (91.7)	20 (80.0)	0.242 <sup>(a)</sup>
No	1 (4.3)	1 (4.2)	5 (20.0)	
Not answered	1 (4.3)	1 (4.2)	0	
Cooking method (Can choose more than one), number (%)				
Boiling	19 (82.6)	22 (91.7)	23 (92.0)	0.124 <sup>(a)</sup>
Steaming	15 (65.2)	17 (70.8)	23 (92.0)	
Frying	1 (4.3)	5 (20.8)	8 (32.0)	
Grilling	0	1 (4.2)	8 (32.0)	
Baking	0	0	1 (4.0)	
Use of seasoning/addition of oil, number (%)				
Use of seasoning	3 (13.0)	6 (25.0)	12 (48.0)	0.019 <sup>(a)</sup>
Adding oil to complementary foods	0	4 (16.7)	3 (12.0)	
No	19 (82.6)	17 (70.8)	13 (52.0)	
Not answered	1 (4.3)	1 (4.2)	0	
Receiving any vitamins or minerals supplementation, number (%)				
Yes	1 (4.3)	6 (25.0)	10 (40.0)	0.297 <sup>(a)</sup>
No	20 (87.0)	16 (66.7)	14 (56.0)	
Not answered	2 (8.7)	2 (8.3)	1 (4.0)	

NA, not analysed (range of age in Group A did not reach these ages).

<sup>(a)</sup> Fisher's exact test.

<sup>(b)</sup> Kruskal–Wallis test.

were different from plant-based protein (PBP), however, their attitudes toward ABP were negative rather than positive. A lower percentage of the 'others' replied that ABP is a good source of iron and zinc compared to the 'mothers' (7.3% vs 22.4%,  $P = 0.034$ ).

When focusing on the difference between respondents who self-defined as primary caregivers and non-primary caregivers, knowledge of ABP as a good source of iron and zinc was also significantly lower in non-primary caregivers compared with primary caregivers (7.0% vs 23.1%,  $P = 0.048$ ; Table S1, Supporting Information).

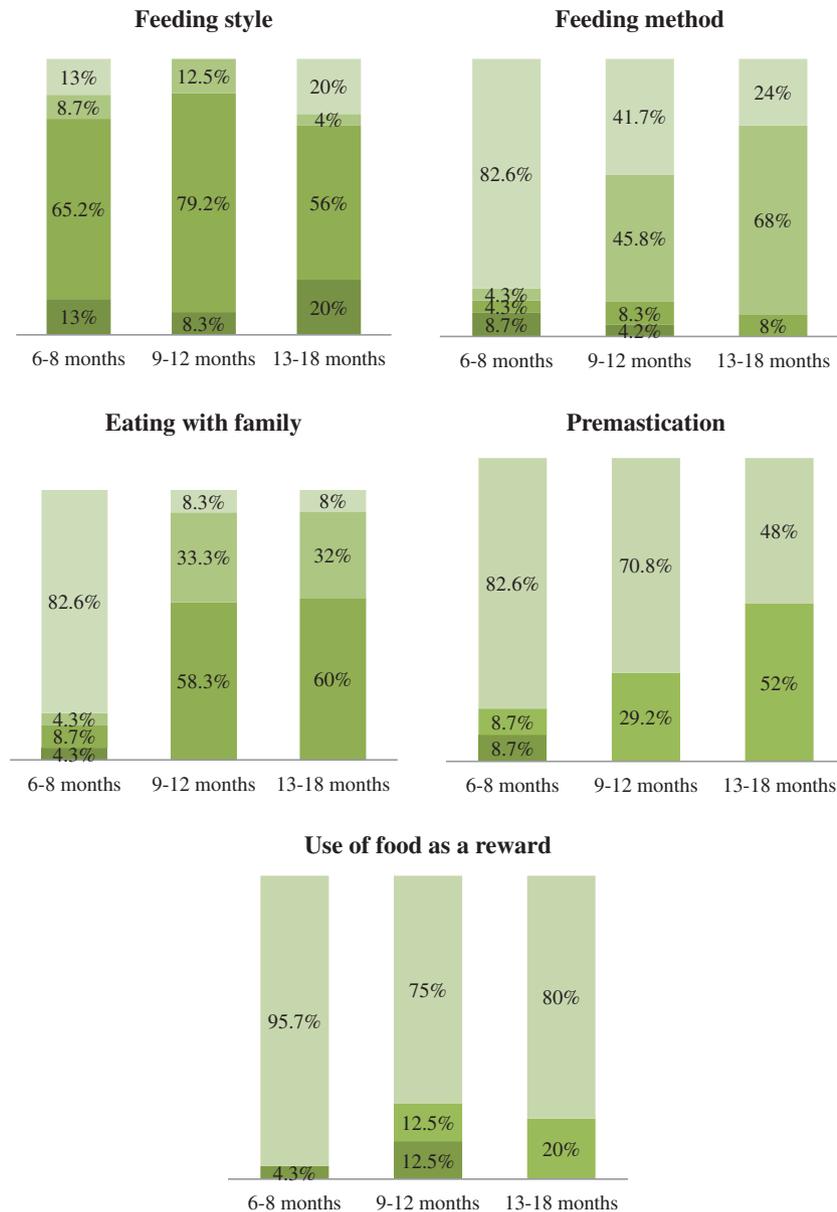
Around 50% of all respondents thought that advice from health-care professionals was the most reliable source of information about IYCF. Considering important factors promoting child growth and development, almost all of the respondents identified exclusive breastfeeding for 6 months. However, the 'mothers' considered appropriate CF as an essential factor more than the 'others' (76.1% vs 56.1%,  $P = 0.017$ ).

Current milk intake is shown in Table 3. More than 50% of all respondents in Group A reported using only breast

milk along with CF compared to around 30% in Group B and C. Among Group C, a majority of respondents reported using formula as the main milk. Interestingly, the proportion using whole cow's milk was very low in all groups. In addition, the percentages of bottle feeding were lower in older infants and children. Half of children in Group B and C were still using a bottle while the rest of them were using a cup or beaker.

Focusing on the timing of introducing complementary food and frequency of main meals, the results were mostly consistent with reported knowledge (Table 2) and consistent with the Thai National guideline. All groups reported rice porridge and mashed banana as the most common first complementary foods while food texture was significantly different among groups, with more lumpy foods fed in Group B and C ( $P < 0.001$ ). Furthermore, the frequency of both main and snack meals was also higher in the older groups.

Interestingly, more than half of the respondents in Group B and C replied that they introduced the first ABP after 6–7 months. Furthermore, egg yolk was emphasised



**Figure 1** Behavioural aspects of feeding practice in different age groups (6–8 months,  $n = 23$ ; 9–12 months,  $n = 24$ ; 13–18 months,  $n = 25$ ). Feeding style: (■) Not answered; (■) Fixed schedule; (■) Responsive feeding; (■) Irregular. Feeding method: (■) Not answered; (■) Self-feeding; (■) Partial support; (■) Total support. Eating with family: (■) Not answered; (■) Frequently; (■) Sometimes; (■) Never. Premastication: (■) Not answered; (■) Yes; (■) No. Use of food as a reward: (■) Not answered; (■) Yes; (■) Never.

as the most commonly used ABP while there was no report of using beef among the groups. Regarding food diversity, the results showed that approximately 60% of the infants in Group A and B did not meet the WHO recommendation.

Although the data indicated that the complementary food was prepared by home cooking in around 90% of the sample, the use of seasoning (i.e. salt and sugar) was significantly higher in the older age group ( $P = 0.019$ ). The most common cooking methods were boiling and steaming, while frying and grilling were used more for older infants but there was no significant difference.

Figure 1 summarises the behavioural aspects of CF among the three groups. Complementary foods were mainly offered following a fixed schedule (offering the meals at nearly the same time every day), while few children were fed by using hunger cues (e.g. smacking lips, sucking fist, restless and crying), so-called responsive feeding. The respondents with older children tended to report independent feeding (children can eat food with partial support or without any help from caregivers) and eating as a family more than those with younger infants. However, unfavourable behaviours such as premastication (pre-chewing food) and using food as a reward were also more frequent in older children, especially in Group C.

## Discussion

The present study demonstrated the attitudes, knowledge and practices associated with CF in urban Thai families. The results showed that the 'others' appeared to have lower confidence and more misunderstandings than the mothers. They were also significantly less likely to value appropriate CF as a factor promoting child growth. For feeding practices, the results showed that most respondents reported timely introduction of CF, giving milk and using feeding methods appropriate for the child's age. However, some families offered a low variety of foods and delayed the introduction of ABP. These practices may cause lower intake of micronutrients, especially iron and zinc. In Thailand, as zinc supplementation is not a routine practice and the coverage of iron supplementation for infants and young children is only 3.6%,<sup>19</sup> consumption of predominantly PBP may not meet the daily requirements for both nutrients and lead to deficiency.<sup>20</sup> Furthermore, the use of seasoning and premastication were reported. While a few families offered food following the infant's hunger cues, the use of food as a reward increased in older children. Both non-responsive feeding and using food as a reward may lead to childhood obesity.<sup>21</sup>

To our knowledge, few studies have reported on the knowledge and attitudes of non-maternal caregivers about CF. One study reported decreased breastfeeding duration and increased juice consumption in infants and toddlers with a non-maternal caregiver.<sup>22</sup> In contrast, a qualitative study focusing on grandmothers from Indigenous populations in New Zealand found that they considered breastfeeding to be a good choice and also thought that home cooking using ingredients from their own gardens without added sugar or salt was the healthiest option. However, some feeding practices were still based on their previous experiences and customary norms.<sup>23</sup>

As previously mentioned, the present study found that the 'others' group had low confidence about feeding their child, were less likely to value CF and had some misunderstandings compared with the mothers group. This suggests that the other caregivers should be targeted for nutritional education in order to improve IYCF. However, further studies are needed as the issues are likely to vary in different settings.

Focusing on practical aspects, the results showed that more than half of infants aged 6–8 months received breast milk alongside CF but the number dropped in the older groups. Similarly, a study in urban areas of Beijing, China also reported decreasing breastfeeding from 51.8% to 25.4% in infants aged 6 and 12 months, respectively.<sup>24</sup> According to a recent survey, the percentage of breastfeeding alongside complementary foods was 21.9% in northern Thailand (infants were 6–23 months old)<sup>25</sup> while the present study reported a higher rate of 36.1% (26 out of 72 who currently received breast milk combined with complementary foods according to Table 3). However, the present study included both breastfeeding and the use of expressed breast milk and only included children up to 18 months of age, which could explain the higher percentage.

In 1992, Jackson *et al.* reported the median age of introduction of CF was only 4 weeks in Thailand.<sup>26</sup> Mashed rice and banana were the most common foods at 3 months of age. By 6 months, ABP was introduced as soft meat and rice mixtures in 45% of the infants, however, the figures increased at 9 and 12 months. In the present study, some 'traditional practices', particularly the use of meat-free diets in the early phase of CF, was still reported, however, this was related to the 'perceptions' of the respondents rather than to affordability. Most of the respondents thought that ABP was 'inappropriate for the gastrointestinal function of the infant' and 'hyper-allergenic' compared with PBP. A review article concluded that caregivers in countries using rice porridge or cereal as first foods believe that rice 'helps with digestion'.<sup>27</sup> On the other hand, evidence suggests that most ABP have high amino acid quality<sup>28</sup> and avoiding them cannot prevent food-protein allergy.<sup>29</sup> Furthermore, Gibson *et al.* found that complementary foods in developing countries including Thailand provide inadequate calcium, iron and zinc.<sup>30</sup> Similarly, a survey of micronutrients in Thai diets also reported that ABP-free diets had lower bioavailability of iron and zinc.<sup>31,32</sup> Therefore, avoiding the delayed introduction of ABP should be addressed in parallel with promoting the CF guideline.

Interestingly, although the percentage of home cooking was high in the present study, the use of seasoning was also common. Likewise, a study revealed over 40% of Vietnamese mothers usually added monosodium glutamate to complementary foods.<sup>33</sup> When compared with commercially infant foods, home-made foods were surprisingly found to be high in salt and low in fat.<sup>34</sup> However, these results should not discourage the use of home-based foods. Instead, families should be educated about how to prepare safe and appropriate foods.

Jackson *et al.* described that most first complementary foods were softened to a semi-solid consistency by pounding and mastication in Thai families.<sup>26</sup> Thirty-five percent of infants were reported to be receiving this type of food at 1–13 weeks of age while the older infants did not receive this practice. It can be assumed that previously, premastication was used in very young infants who had limited ability to chew solid food. In contrast, the present study found the percentage of reported premastication was higher in older groups. The most serious potential consequence of this practice is the transmission of pathogens such as Hepatitis B virus and human immunodeficiency virus (HIV),<sup>35</sup> from caregivers to infants particularly if the caregiver has gingival bleeding or periodontal disease.<sup>36</sup> There are reported cases that might indicate transmission of HIV from foods pre-chewed by HIV-infected caregivers.<sup>37</sup> Although there are theoretical benefits of premastication,<sup>38</sup> pending availability of more robust data families should be advised to avoid it, especially in countries where HIV infection is prevalent.<sup>39</sup>

The present study had some limitations including the small number of respondents and the fact that some respondents were not the primary caregiver. However, a subgroup analysis including only data from respondents who were primary caregivers revealed similar findings. The

recalled data especially from the respondents with older children may have affected the accuracy of some results.

In summary, the present study highlights the role of other family members as key players in CF in middle-class urban Thai families. Currently, most urban Thai families report timely introduction of CF but certain aspects and feeding practices such as the use of pre-mastication need more attention. The present study also provides some new information. Improved understanding of the reasons why caregivers do not follow advice, or adopt undesirable practices, would allow the IYCF guidelines to be adjusted in the future.

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## Conflict of interest

The authors have no conflicts of interest to declare.

## Authorship

KK conceptualised and designed the study, collected data, analysed the statistics, interpreted the results, wrote and revised the first draft of manuscript as well as approving the final draft. MF conceptualised and designed the study, revised the manuscript and approved the final draft. JL revised the manuscript and approved the final draft. KR and CP collected the data and approved the final draft.

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### Supporting information

Additional Supporting Information may be found in the online version of this article at the publisher’s web-site:

**Table S1** Knowledge and attitudes related to complementary feeding between primary and non-primary caregivers.

## Appendix

### The Thai national guideline for complementary feeding (in 2016)<sup>17</sup>

Age (months)	Carbohydrate (per meal)	Protein (per meal)	Vegetable (per meal)	Fruit (per day)	Oil (per day)	Characteristics of food
6 (1 meal)	Finely mashed rice, 2 tbs	½ Egg yolk alternate with meat, 1 tbs	Boiled vegetable, ½ tbs	Ripe fruit, 1 piece	½ Tea spoon	Finely ground
7 (1 meal)	Soft cooked rice, 3 tbs	½ Whole egg alternate with meat, 1 tbs	Cooked vegetable, 1 tbs	Ripe fruit, 2 pieces	½ Tea spoon	Roughly ground
8 (2 meals)	Soft cooked rice, 4 tbs	½ Whole egg alternate with meat, 1 tbs	Cooked vegetable, 1 tbs	Ripe fruit, 3 pieces	½ Tea spoon	Roughly ground
9–12 (3 meals)	Soft cooked rice, 4 tbs	½ Whole egg alternate with meat, 1 tbs	Cooked vegetable, 1½ tbs	Ripe fruit, 4 pieces	½ Tea spoon	Roughly ground
13–36 (3 meals)	Cooked rice, 6 tbs (1 ladle)	½ Whole egg alternate with meat, 1 tbs	Raw/cooked vegetables, 4 tbs	Fresh fruit, 3 portions <sup>(a)</sup>	3 Tea spoons	Family food

tbs, table spoon.<sup>(a)</sup>One portion of fresh fruit = 15 g of carbohydrate from fruit (e.g. 1 portion = 1 medium size orange, 1 apple, ½ guava, ½ Cavendish banana).

## ORIGINAL RESEARCH

## Added sugar and sodium levels in New Zealand processed fruit and vegetable-based products

Lynne CHEPULIS <sup>1</sup>, Nadine EVERSON,<sup>2</sup> Amanda HEAPY<sup>3</sup> and Gael MEARNs<sup>4</sup><sup>1</sup>Waikato Medical Research Centre, University of Waikato, Hamilton, Departments of <sup>2</sup>Nursing and <sup>3</sup>Health and Social Services, Toi Ohomai Institute of Technology, Rotorua and <sup>4</sup>School of Clinical Sciences, Auckland University of Technology, Auckland, New Zealand**Abstract****Aim:** Fruit and vegetables are strongly promoted because of the nutrients they provide; many processed products contain added sugar and sodium. The present study aims to quantify the sugar and sodium content of pre-packaged fruit and vegetable-based products that are available in New Zealand supermarkets.**Methods:** Nutrition Information Panel data were collected from non-frozen, processed fruit and vegetable products in New Zealand supermarkets (including soups, sauces, jams and spreads, pickles, chutneys and dips, and canned/bottled fruit and vegetables) where fruit and/or vegetables were the majority ingredient(s).**Results:** With the exception of canned/bottled vegetables, more than 60% of products contained added sugar. Per serve, the median sugar content was highest in canned/bottled fruit (17.8 g). More than 75% of soups, vegetable-based sauces, pickles/chutneys and canned/bottled vegetables contained added sodium, with soups (722 mg) recording the highest median values per serve.**Conclusions:** Consumers need to be aware that although they are encouraged to eat a diet high in fruit and vegetables, there may be large quantities of added sugar and sodium in manufactured fruit and vegetable products that can have significant negative impacts on their health. Government health promotion campaigns encouraging the consumption of fruit and vegetables should be careful to target fresh, frozen and home-prepared foods, and work on educating the public about the lower nutritional quality associated with most processed fruit and vegetable products.**Key words:** added sodium, added sugar, processed fruit and vegetables.**Introduction**

Public health campaigns regularly promote fruit and vegetable consumption due to the variety of vitamins, minerals and dietary fibre that they provide, with the aim of reducing population incidence of chronic disease.<sup>1</sup> Indeed, fruit and/or vegetable intake has been positively associated with a decreased risk of type 2 diabetes,<sup>2</sup> slower weight gain/reduced adiposity,<sup>3</sup> and reduced risk of coronary heart disease.<sup>4</sup>

Government guidelines in New Zealand and Australia recommend and actively promote consuming at least two servings of fruit and three<sup>5</sup> to five<sup>6</sup> servings of vegetables, respectively, per day. General public perceptions of fruit

and vegetable products is that they are healthy,<sup>7</sup> although actual intakes are questionable as recommended intakes and portion sizes are often not correctly identified.<sup>8</sup> Furthermore, evidence suggests that supermarkets are now dominated by ultra-processed foods including many packaged and processed fruit and vegetable products.<sup>9</sup> Such foods are nearly always less healthy than those that are minimally or not processed,<sup>9</sup> often containing increased levels of sugar and salt in an attempt to increase the palatability of food.<sup>10</sup> However, while consumers do perceive processed foods to be less healthy,<sup>7</sup> anecdotal evidence suggests that there are mixed messages between the 'unhealthiness' of a processed fruit or vegetable product and the requirement to add more fruit and vegetables into the diet. Importantly, there appears to be limited information specifically describing the nutritional profile of processed fruit and vegetable products in Australia and New Zealand. Only a small number of studies have reported on the sodium content of processed foods<sup>11–13</sup> and there appears to be a complete lack of published literature describing the sugar content of processed foods in Australia and New Zealand. Given the significance of sugar and salt on the development and progression of chronic disease,<sup>14</sup> and the knowledge that

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up to 90% of the energy from added sugars comes from processed foods,<sup>15</sup> the current study aims to evaluate the sugar content and sodium levels in processed fruit and vegetable products available in New Zealand supermarkets.

## Methods

Nutritional composition data were collected from all processed fruit and vegetable-based products from three large supermarket chains (Countdown, Pak 'n' Save and New World) in Rotorua, New Zealand stores during November to December 2017. These supermarkets represent approximately 92% grocery market share.<sup>16</sup> Data were obtained from both the online grocery shopping websites and by visiting the stores in person and taking photographs of the packaging, ingredients list and nutritional information panel (NIP) of each product. Products with multiple package sizes were included only once into the product dataset (unless different product sizes had different nutritional information). For reliability, 10% of products from which the NIP data were sourced online were manually checked against actual product information in store.

Products were included in the dataset if they were a non-frozen, processed fruit and vegetable-based product with a full NIP available. Products were deemed to be fruit or vegetable-based if fruits or vegetables were listed either first or second on the ingredients list, and if the total fruit and vegetable content of the product was at least 25% (where described in the ingredients list). Products were excluded if they were not packaged as a ready-to-eat product, including all concentrates (e.g. tomato paste) and marinades.

For each product, the following data were recorded: brand name, product name, packet size, manufacturer-declared serving size, ingredients list, content of energy (kJ), protein, fat (total), carbohydrate, sugar and sodium (per 100 g and per manufacturer-declared serve). The percentage of products that had sugar (defined as sugar, cane sugar, honey, glucose–fructose syrup, glucose, sucrose, fructose, and/or high fructose corn syrup) or sodium (including 'monosodium glutamate' and 'salt') added to them were also recorded. Labels where the amount of a nutrient was recorded as <1 g, <0.1 g or <5 mg were entered as 0.5 g, 0.05 g and 2.5 mg, respectively, into the spreadsheet.

All product categories, as well as certain sub-categories (e.g. baked beans, other beans, pasta sauce and canned tomatoes) were assessed and compared for differences in sugar and sodium content as well as the proportion of products with added sugar/sodium. The number of products promoting a 'low sugar' option (including use of the terms 'no added sugar', '50% less sugar', 'low sugar') or reduced sodium ('reduced salt', 'no added salt', 'low sodium', 'reduced sodium') were also analysed.

Canned/bottled fruit data were further analysed to determine whether there was a difference in the proportion of products that were canned/bottled in syrup versus in juice with regard to: (i) the median sugar content, (ii) the

proportion of products with added sugar and (iii) the proportion of products that were promoted as being 'low sugar'.

The nutritional quality of a small number of processed products that contained only one fruit or vegetable ingredient were then compared to fresh alternatives. The nutritional information for fresh products was taken from the United States (US) Food and Drug Administration (FDA) 'Nutrition information for raw fruits, vegetables and fish'.<sup>17</sup> Processed fruit and vegetable nutrition information was sourced from the present study data, with values reported being those with the highest sugar/sodium content across all comparable products (e.g. all whole canned tomato products).

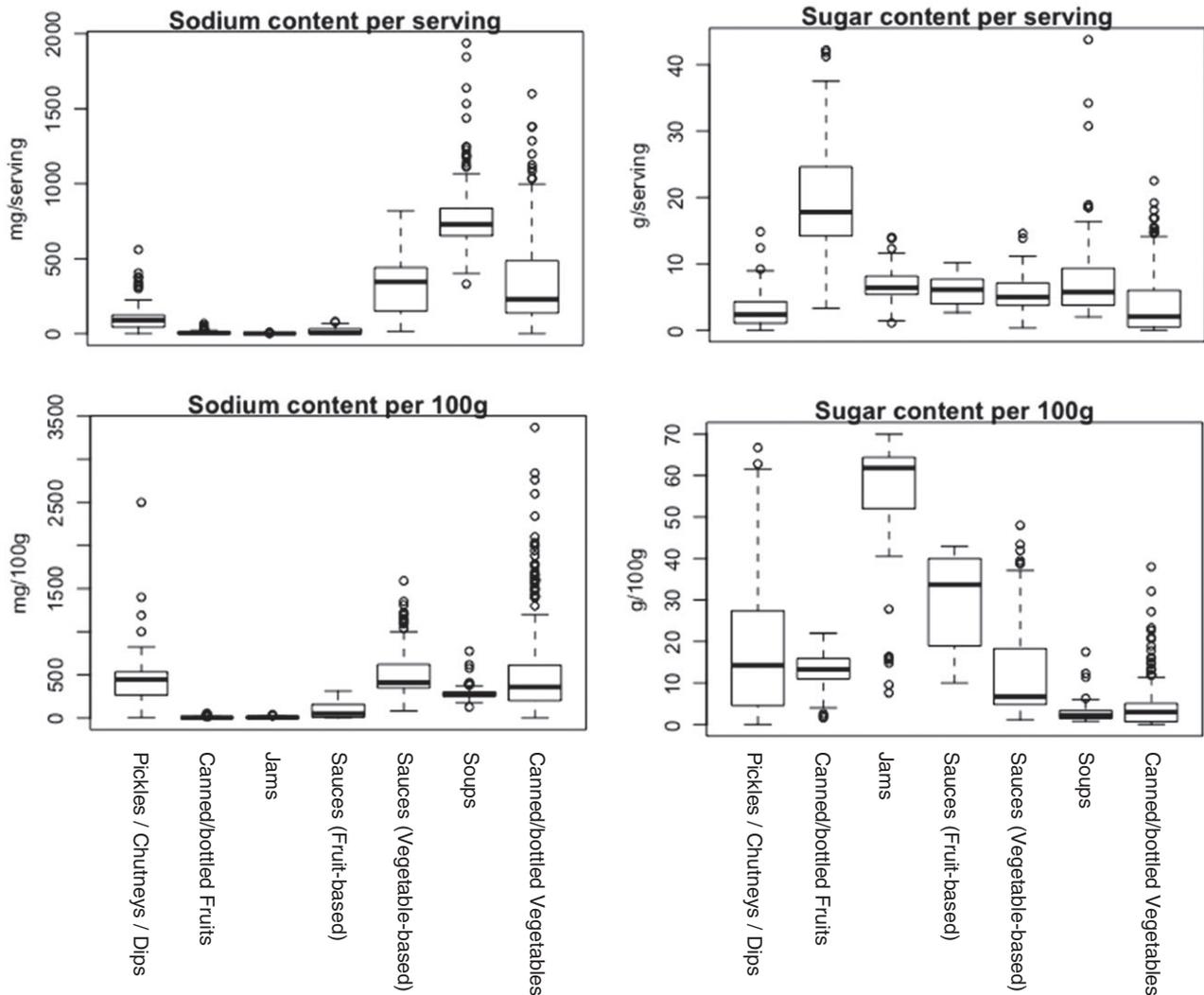
As NIP information is largely dependent on manufacturer-declared serve size, the present study also assessed the difference in serving size across a number of categories and sub-categories for the impact that this may have on interpretation of nutritional information. Manufacturer-declared serve size information from various product categories/sub-categories was compared to the 2018 US FDA recommended serve size information.<sup>18</sup> These values are reported as reference amount of customarily consumed (RACC) values. US FDA guidelines were used rather than New Zealand guideline values, as current serving size guidelines in New Zealand are difficult to quantify for processed fruit and vegetable products.<sup>5</sup>

The data were analysed using R version 3.2.0 (R Core Team, Austria) for OSX. As most variables were not normally distributed, category level summary statistics are reported as median and interquartile range (IQR). Kruskal Wallis testing with Dunn *post hoc* analysis was used to determine variance for the sugar and/or sodium content of all categories, canned fruit sub-categories, and chi-square comparisons for the proportion of canned fruit with added sugar.

## Results

A total of 899 products were analysed across seven categories, including soups (n = 106), vegetable-based sauces ('vegetable sauces'; n = 176), fruit-based sauces ('fruit sauces'; n = 16), jams and spreads ('jams'; n = 72), chutneys, pickles and dips ('chutneys'; n = 121), canned/bottled vegetables ('canned vegetables'; n = 286) and canned/bottled fruit ('canned fruit'; n = 122).

The proportion of products with added sugars was high across all categories: 88.9% (jams), 87.5% (fruit sauces), 80.7% (vegetable sauces); 78.3% (soups), 76.9% (chutneys), 60.7% (canned fruits) and 42.9% (canned vegetables). Per serve, canned fruits had the highest median sugar content with 17.8 g (IQR = 14.2, 24.6) with all other product categories averaging under 6.5 g per serve (Figure 1). Jams had the highest sugar content per 100 g (median: 61.8 g; IQR = 52.0, 64.4), this being significantly higher than all categories except fruit-based sauces (31.6 g; IQR = 14.9, 40.0;  $H = 327.6$ ;  $P < 0.0001$ ). The median



**Figure 1** Sugar and sodium content per 100 g and per manufacturer-declared serve of fruit- and vegetable-based products (box plots report median, IQR, maximum and minimum).

sugar content (per 100 g) of other product categories ranged from 2.2 g (soups) to 14.2 g (chutneys) (Figure 1).

When compared across product groups, fruit canned in syrup contained significantly more sugar per single serve compared with fruit canned in juice (median: 23.4 g vs 14.6 g;  $H = 27.3$ ;  $P < 0.001$ ), and a lower proportion of fruits in syrup were promoted as being lower in sugar (14.8% vs 29.8% of fruit in juice;  $\chi^2 (1, n = 108) = 3.5$ ,  $P = 0.05$ ). However, there was no statistically significant difference between the median sugar content per serve of ‘all’ fruits canned in syrup compared to those promoted as being ‘low sugar’ (23.4 g vs 25.8 g;  $H = 0.27$ ;  $P = 0.60$ ). This result was offset by differences in the manufacturer recommended serve size, with ‘low sugar’ syrup products being marketed with a higher manufacturer-declared serve size than fruit canned in syrup (median: 205 g vs 135 g; Table 1). Importantly, ‘low sugar’ fruits in syrup still contained over one-third more sugar per serve than fruit in juice (25.8 g vs 14.6 g;  $H = 3.7$ ;  $P = 0.05$ ) and twice as much sugar as ‘low sugar’ fruits in juice (25.8 g

vs 12.9 g;  $H = 3.4$ ;  $P = 0.06$ ); though again median serve size differed across these categories (Table 1).

Further analysis of the canned fruit data in our study indicated that the products with the lowest sugar content per serve (<10 g,  $n = 14$  (11.5%)) contained mostly fruit and water, half contained ‘sweeteners’, and only two products contained sugar. In contrast, of the products with the highest sugar content per serve (>25 g,  $n = 26$  (21.3%)), 100% contained added sugar, and all were fruits canned in syrup. One-quarter of these 26 ‘highest sugar’ products ( $n = 6$ ) were fruits canned in ‘light syrup’.

The proportion of vegetable-based products with additional salt was high, including nearly all soups (94.4%) and vegetable sauces (96.0%) as well as more than three quarters of all canned vegetables (75.4%) and chutneys (79.3%). One-third of fruit-based sauces contained added salt, but less than 4% of other fruit-based products (Table 2).

Due to the proportionately larger serve size (median: 250 g; IQR = 250, 300), soups had the highest median

**Table 1** Sugar content of canned fruit products

Product	Number of products	Manufacturer-declared serve size (g; median [IQR])	Sugar per serve (g; median [IQR])	Proportion of products with added sugar (%) <sup>1</sup>	Proportion of products promoting 'low sugar' (%) <sup>1,2</sup>	
All canned fruit <sup>3</sup>	122	125 [120, 205]	17.8 [14.2, 24.6]	54.9	20.5	
Canned fruit in syrup <sup>4</sup>	61	135 [120, 205]	23.4 [18.7, 27.0]	95.1 <sup>a</sup>	14.8 <sup>a</sup>	
	'Full sugar' syrup	52	132.5 [117, 205]	23.6 [18.8, 30.3]	100	—
	'Low sugar' versions <sup>1</sup>	9	205 [205, 205]	25.8 [14.2, 26.4]	66.7 <sup>b</sup>	—
Canned fruit in juice <sup>4</sup>	47	125 [117, 147]	14.6 [11.4, 16.4]	6.4 <sup>c</sup>	29.8 <sup>b</sup>	
	'Low sugar' versions <sup>1</sup>	16	120 [112, 200]	12.9 [9.3, 15.2]	6.3 <sup>c</sup>	—

<sup>1</sup> Letters within the same column are significantly different from each other as per Dunns *post hoc* test ( $P < 0.001$ ).

<sup>2</sup> Include the terms 'no added sugar', '50% less sugar' and 'low sugar'.

<sup>3</sup> Includes all canned fruit products, including those in syrup, in juice and those for which the liquid was not defined (or was not present, e.g. pureed fruit).

<sup>4</sup> Based on the wording on the product label.

level of sodium per serve (721.8 mg; IQR = 654.4, 834.2). However, vegetable-based sauces also contained high sodium content (median: 318.6 mg; IQR = 156.2, 440.9) despite an average serve size of only 83.5 g (IQR = 20, 125). Per 100 g of product, the highest median sodium was observed in chutneys (444.5 mg; IQR = 268, 533), this being significantly higher than all categories except vegetable-based sauces (403.0; IQR = 333, 702) and canned vegetables (357.5; IQR = 191.0, 600.0) ( $H = 252.3$ ;  $P < 0.0001$ ). The lowest sodium content was observed in fruit-based sauces, jams and canned fruits, with comparable values across all three categories. The sodium content of all primary categories is given in Figure 1 and Table 2.

Sub-category analysis showed that baked beans contained the highest median level of sodium per serve (805.8 mg), this being nearly twice that of other bean products (448.1 mg;  $H = 15.2$ ;  $P = 0.0001$ ). Pasta sauces also contributed, on average, more than 400 mg of sodium per serve. The sodium content within most sub-categories varied greatly (see below) and was not entirely described by differences in manufacturer-declared serve size. Sodium content of baked beans, for example, varied 5-fold from 260 to 1380 mg per serve, (minimum, maximum) despite only a 2.5-fold difference in serving size (125–300 g).

Of the eight different fresh/processed products compared, all had a lower nutritional profile after processing compared to their fresh alternatives (Table 3). The sugar content of canned fruit was 26%–101% higher compared with fresh fruit (per 100 g of product), while the sodium content of beans, corn and whole tomatoes increased dramatically from an average of 2.0–5.6 mg per 100 g in fresh products to 115–250 mg in the canned alternatives. In contrast, small reductions in sugar content were seen in canned vegetables compared to their fresh counterparts (Table 3).

Manufacturer-declared serving size was highly variable across all categories and sub-categories that were assessed (Table 2). Based on US FDA RACC guidelines, more than 80% of baked beans and soups exceeded the suggested serve size, as well as approximately one-third of all pasta sauces, canned vegetables, canned fruit and other beans.

## Discussion

Processed foods are known to be significant contributors of sugar and sodium,<sup>10</sup> and our data suggests that this is also true for processed fruit and vegetable products, despite the fact that they are often perceived to be healthy food products.<sup>7</sup>

It is concerning that up to 90% of all products surveyed in the present study contained added sugars. While high sugar content is generally expected for products such as jams and spreads, high levels were also seen in other product categories. One-third of all chutneys and pickles also contained more than 20% sugar, with 10% of products in this category containing more than 30% sugar. It has been reported that chutneys and pickles sales have declined in the UK in recent years, particularly with younger generations.<sup>19</sup> Thus, while specific sales data for New Zealand were not available, it is possible that the relatively high sugar content of many of these products is manufacturer-driven in order to deliver a product that better meets consumer preference for sweetened products. The data in the current study also reported that the median sugar content from canned fruits was high with more than 75% of all canned fruit products providing 3–5 teaspoons (15–25 g) of sugar per serve. These products are an important contributor to daily sugar intake given that current World Health Organisation recommendations suggested limiting free sugars to approximately 5% of the total energy intake

**Table 2** Sodium content and manufacturer-declared serve size information of processed vegetable-based products

Product	Manufacturer-declared serve size (g)				Sodium content			Serving size	
	Number of products	Median [IQR]	Minimum	Maximum	Sodium per serve (mg; median [IQR])	Proportion of products with added sodium (%)	Number of products promoting 'low sodium/salt' (%) <sup>(a)</sup>	RACC serve size (g) <sup>(b,c)</sup>	Proportion of products exceeding (%) RACC
Soups	106	250 [250, 300]	200	450	721.8 [654.4, 834.2]	94.4	3 (2.8%)	245	88.7
Fruit-based sauces	16	25 [14, 30]	10	30	5.0 [2.9, 45.2]	31.3	0 (0%)	—	—
Jams	72	10 [10, 15]	10	50	0.5 [0.4, 1.5]	1.3	0 (0%)	20	5.6
Vegetable-based sauces	176	83.5 [20, 125]	10	300	318.6 [156.2, 440.9]	96.0	4 (2.3%)	—	—
Tomato sauces <sup>(d)</sup>	32	15 [15, 15]	10	50	142.1 [94.1, 164.3]	86.7	3 (10%)	30	9.4
Pasta sauce <sup>(e)</sup>	79	125 [100, 127]	80	188	437.5 [372.4, 477.9]	97.4	1 (1.3%)	125	29.1
All canned vegetables	286	120.5 [50, 130]	45	300	221 [135.7, 461.8]	75.4	9 (11.3%)	130	35.3
Baked beans	25	210 [205, 210]	125	300	805.8 [504.7, 981.1]	96.0	2 (8%)	130	84.6
Canned tomatoes	36	100 [80, 130]	80	200	120.0 [15.0, 172.0]	44.5	1 (2.8%)	130	25.7
Canned beans (non-baked)	45	130 [108, 200]	60	225	448.1 [201.1, 585.7]	82.2	1 (2.2%)	130	37.8
All canned fruit	122	125 [120, 205]	85	212	4.1 [3.1, 10.2]	3.8	0 (0%)	140	32.2
Pickles/chutneys/dips	121	20 [15, 25]	10	47.5	89.8 [42.6, 123.7]	79.3	0 (0%)	—	—

<sup>(a)</sup> Includes the terms 'reduced salt', 'reduced sodium' and 'low sodium'.

<sup>(b)</sup> Data taken from 2018 Food and Drug Administration (FDA) recommendations.<sup>19</sup>

<sup>(c)</sup> Only products with equivalent reference amount of customarily consumed (RACC) serve size information is reported.

<sup>(d)</sup> Includes all sauces that include the terms 'tomato sauce', 'ketchup' or 'pizza sauce'.

<sup>(e)</sup> Includes all sauces that include the terms 'pasta sauce' or 'bolognese sauce'.

per day (equal to ~30 g of sugar in a person aged over 11 years).<sup>20</sup> However, it is important to note that New Zealand NIP labels currently do not distinguish between added sugars and those occurring naturally in food ingredients such as fruits and dairy.

Our data showed that there was a difference in the sugar content of canned fruits with many of the highest sugar products being canned in 'light syrup'. In addition, there was no significant difference in the sugar content of fruits canned in 'light syrup' versus those in full sugar syrup, while products canned in 'light syrup' contained up to twice as much sugar as fruits canned in juice. This is a strong, yet misleading message that fruits canned in 'light syrup' may be healthier, or nutritionally better than their full syrup counterparts. Instead, products canned in juice should be more strongly promoted as being healthier options.

As Table 3 shows, canned fruits were also generally a poorer nutritional choice than their fresh alternatives. New Zealand nutrition guidelines recommend at least two servings of fruit per day and processed foods look likely to remain an important contributor of the typical western diet. This suggests that policy and nutrition guidelines should continue to advocate for increased fruit and vegetable intake, including from canned goods, but that consumers should be made aware of the importance of selecting fruits canned in juice or water rather than syrup. More research is

needed on fresh versus processed fruit and vegetable consumption and the factors that influence purchasing and consumption patterns.

The 5+ a day model promotes that at least three servings of the 5+ per day should be vegetables.<sup>5</sup> However, there appears to be little current data describing the vegetable intake patterns of New Zealanders, including what proportion of vegetables are from processed sources. What is most concerning from our data is the sodium content of many processed vegetable products, particularly as studies report a causative link between sodium intake and reduced health.<sup>21</sup> Current New Zealand Guidelines suggest that the recommended daily intake of sodium ranges from 930 to 2300 mg<sup>5</sup> and in our study a number of vegetable-based products reached these lower limits in only one serve.

It is also important to note that data about which foods contribute to sodium intake in New Zealand is considerably out of date. The 2015 Eating and Activity Guidelines for New Zealand<sup>5</sup> refer to the 1997 National Nutrition Survey to describe key sources of dietary sodium. However, both this and another study which used dietary recall data<sup>11</sup> suggest that New Zealanders regularly consume more than the recommended amounts of sodium. A recent review of 182 New Zealand processed foods (including breads, cereals, butters, canned meats, cheese, crackers and canned vegetables) indicated that there has been little change in the sodium content of these foods overall between 2003 and

**Table 3** Sodium and sugar content of example processed<sup>(a)</sup> versus fresh<sup>(b)</sup> fruit and vegetables

Product	Product/ serve size (g)	Energy (kJ)		Sugar content (g)		Sodium content (mg)		
		Per serve	Per 100 g	Per serve	Per 100 g	Per serve	Per 100 g	
<b>Fruits</b>								
Apples	Fresh, one large	242	546	225.6	25.0	10.3	0	0
	Pie filling, apple	125	425	340.0	16.3	13.0	3.75	3.0
Peaches	One medium	147	252	171.4	13.0	8.8	0	0
	canned (slices in syrup)	205	410	200.0	21.8	10.6	4.1	2.0
Pears	One medium	166	420	253.0	16.0	9.6	0	0
	canned (quarters in syrup)	205	492	240.0	27.1	13.2	4.1	2.0
Plums	Two medium	151	294	195.3	16.0	10.6	0	0
	canned (in syrup)	212	355	167.5	42.2	19.9	4.2	2.0
Pineapple	Fresh, two slices	112	210	187.5	10	8.9	0	0
	Canned (slices in syrup)	125	288	230.4	23.4	18.7	2.9	2.3
<b>Vegetables</b>								
Beans	Fresh, green, whole	100	105	105.0	2.4	2.4	3.0	3.0
	Canned (4-bean mix)	125	863	690	1.0	0.8	143.8	115.0
Corn	Fresh, kernels from one ear	90	328	464.0	5	5.6	5.0	5.6
	Canned (kernels)	80	288	360.0	2.6	3.25	100.0	125.0
	Canned (creamed corn)	100	405	405.0	2.9	2.9	165.0	165.0
Tomatoes	Fresh, one medium	148	105	70.9	20	13.5	3.0	2.0
	Canned (whole, peeled in juice)	80	64	80.0	2.4	3.0	200.0	250.0

<sup>(a)</sup>Data extracted from study data. Values reported are those for products with the greatest sugar/sodium content across all comparable products.

<sup>(b)</sup>Information taken from the United States Food and Drug Administration 'Nutrition information for raw fruits, vegetables and fish'.<sup>17</sup>

2013, though their data report that the median sodium content of canned vegetables (n = 39) decreased from 241 to 137 mg/100 g during this time.<sup>22</sup> Sub-category analysis showed that a number of baked bean products (n = 9) decreased their sodium content by approximately 10% during this 10-year period achieving a median sodium value in 2013 of 415 mg/100 g.<sup>22</sup> This is comparable to the results seen in our study with 2017 data. This is an important finding suggesting that manufacturers may be reformulating to meet consumer needs; however, the results of the present study are indicative at best, the authors themselves noting that any conclusions are confounded by changes in market availability and a lack of sales-weighted data. That said, very few products in our study were promoted as being low in sodium and this is something that could easily be implemented, thereby allowing consumers to easily recognise low-sodium options.

In addition, it is important to identify that all serving size information used in our study refers to manufacturer-reported information on the NIP labels. This itself is variable, with at least a 2–3 times difference in size across comparable products in many sub-categories. Adherence to such portion sizes is also questionable, with evidence suggesting that consumers regularly consume higher serve sizes than those recorded on product packaging,<sup>23</sup> instead often using factors such as container size<sup>24</sup> to determine the portion consumed. It would be useful in future studies to evaluate public perceptions of portion size, and knowledge of dietary guidelines to determine what impact these have on purchasing choice or consumption patterns.

Government campaigns in New Zealand continue to promote the intake of fruit and vegetables, but little emphasis is placed on the quality or source of these foods. New Zealand Ministry of Health guidelines do suggest that New Zealanders should actively choose canned fruit and vegetables that offer reduced sugar and sodium levels,<sup>5</sup> though it is questionable whether this message is promoted alongside that to increase fruit and vegetable intake. Furthermore, while it has been shown that many consumers are often aware of the sodium content of processed foods, most do not use or check NIP labels to determine sugar<sup>25</sup> or salt<sup>26</sup> content. Thus, it is suggested that front-of packaging labels using ‘reduced’ claims may be a more effective means at targeting the general populace to influence product choice.<sup>27</sup> Strategies should also be implemented to encourage the specific intake of fresh fruit and vegetables (and/or home-made products) rather than processed alternatives. Additionally, more research is needed on factors influencing consumer purchasing and consumption patterns, to identify and address why consumers may prioritise processed fruit and vegetables over fresh products. Lastly, it would be valuable in future studies to assess fruit and vegetable products that were not included in the present study (e.g. crisps, marinades and product concentrates), and to include products from multiple regions of New Zealand so as to avoid any location bias.

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## Conflict of interest

The authors have no conflict of interest to declare.

## Authorship

LC designed the study, supported data collection/analysis and prepared the manuscript. NE collected all data and prepared data for analysis. AH supported study design and manuscript writing. GM contributed to statistical analysis and manuscript writing. All authors have contributed to the critical revision of the article, have reviewed the final version and approved the manuscript.

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**ORIGINAL RESEARCH****Advice and recipes for invalid and convalescent cookery in Australian cookbooks 1860–1950**Peter WILLIAMS *Faculty of Health, University of Canberra, Canberra, ACT, Australia***Abstract**

**Aims:** The aims of the present study were to assess the prevalence of recipes about invalid cookery in Australian cookbooks published from 1860 to 1950; describe the dishes regarded as suitable for invalids and summarise the advice about how best to feed invalids or convalescents in the home.

**Methods:** Using published bibliographies, the Trove database, and the author's private collection, all available cookbooks published in Australia up to 1950 were reviewed and all recipes and advice about feeding invalids were recorded.

**Results:** Eight hundred and eighty-nine book titles were examined and 25% contained some recipes specifically designed for people who were sick or convalescing. One thousand, four hundred and seventy-one different recipes were recorded with more than half for beverages, desserts and soups. The most common recipes were for beef tea, barley water, gruel and meat broths. Advice about feeding focused on the food requirements of invalids, safe and appealing meal service, cooking methods and suitable food choices. The recipes and advice did not appear to change substantially over the nine decades and most did not appear to be based on any clear scientific evidence.

**Conclusions:** Many of the general principles of invalid cookery in these books are similar to the requirements of the light diet, commonly used in Australian hospitals up until the 1980s. Further research into the source and rationale for the advice in these books would be worthwhile.

**Key words:** convalescent, cookbooks, cookery, invalid.

**Introduction**

Well before the employment of the first dietitians in Australia in the 1930s, advice about the preparation of food for sick patients could be found in the pages of domestic cookbooks. The Australian market for books in the nineteenth century was small, and British publishers sold standard British works, including cookbooks, in Australia. However, from the 1860s onwards a growing number of local cookbooks were published. The first book that included any food recipes was 'Ice and its uses' published in Adelaide, with 58 recipes for ice creams, jellies, fruit ices and iced drinks.<sup>1</sup> The earliest known Australian cookbook is 'The English and Australian Cookbook. Cookery for the many as well as for the "Upper Ten Thousand" by An Australian Aristologist', published in Hobart in 1864.<sup>2</sup> That book included one recipe specifically designated as suitable for the sick: Invalid Biscuits (made with butter, milk, sugar, yeast and caraway seeds). Thereafter many Australian cookbooks included a whole section of general advice and

recipes for those preparing food for invalids. Various terms were used to describe these recipes, including foods for the invalid, convalescents or the sickroom. For simplicity, throughout the present study the umbrella term of 'invalid cookery' is used.

Several authors have used cookbooks as a source of historical information about patterns of eating and nutrition knowledge<sup>3–7</sup> but there have been no published studies of their recommendations about invalid cookery, and the aims of this paper are to:

- 1 Assess the prevalence of recipes about invalid cookery in Australian cookbooks published in the nine decades from 1860 to 1950.
- 2 Describe the types of dishes regarded as suitable for invalids.
- 3 Summarise the general advice about how best to feed invalids or convalescents in the home.

The origin of invalid cookery recipes is a topic of emerging research interest,<sup>8–11</sup> but beyond the scope of this article. Consideration of the sources and appropriateness of the advice and recipes will be published in a separate paper.

**Methods**

There are two main bibliographies of Australian cookbooks. A list of books published prior to 1941 was produced by

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Bette Austin, with 576 entries.<sup>12</sup> A much larger authoritative bibliography by John Hoyle catalogued domestic cookery books from 1860 to 1950.<sup>13</sup> It has 1418 entries, but that number includes separate entries for each edition of the same title; the number of unique titles is 719. However, as both Austin and Hoyle note, their bibliographies are not complete, and further titles are likely to continue to be discovered. The author has a private collection of 330 Australian cookbooks published before 1950 and 115 are not included in either of those two bibliographies.

For the present study, all the books listed in the two published bibliographies were examined, along with the additional items in the author's collection, and 42 books in the National Library of Australia and the State Library of NSW that were not captured in either of the published bibliographies. The location of items was identified by searching the Trove database (<https://trove.nla.gov.au>). Most publications are cookbooks, but some are more general books on health, home maintenance or the use of new kitchen appliances, which include some recipes as well. In each case a list was made of the recipes in any separate section called invalid, convalescent or sickroom cookery. If books did not include such a specially indicated section, any recipes that had a word in the title indicating their use (e.g. Invalid's soup) were also noted. As far as possible, every edition of each title was examined.

Many cookbooks included general advice or rules about how to feed a sick person, including safe food preparation, the arrangement of a meal tray, and ways to tempt patients with poor appetite. The text of these entries was also collected and examples of this advice, along with the recipes, have been published in an annotated bibliography.<sup>14</sup>

The timeframe chosen was from 1860 to 1950, for two reasons. The first is that this corresponds with the dates in Hoyle's bibliography. Secondly, the number of recipe books published grew greatly after the Second World War and most no longer included advice about invalid cookery. The books after 1950 that were examined in this study were later editions of works first published before 1950.

One particular problem was determining the date of publication. Hoyle notes that in his bibliography only 37% of the books include a date from the publisher or printer. Wherever possible he provided estimates using information such as handwritten annotations, library acquisition dates, and internal evidence from advertisements, calendars and telephone numbers. Where there is no published date, the estimates of Hoyle, or those of librarians as listed in the catalogue entries in Trove, have been used in this study.

## Results

*Recipes:* Table 1 summarises the prevalence of invalid cookery recipes in Australian cookbooks published during 1860–1950. Altogether, 889 separate book titles were

**Table 1** Prevalence of invalid cookery recipes in Australian cookbooks

Years	Number of book titles first published in this decade <sup>(a)</sup>	Number of books including invalid recipes	Percentage of books including invalid recipes
1860–1889	33	10	30
1890–1899	60	22	37
1900–1909	59	26	44
1910–1919	85	42	49
1920–1929	170	51	30
1930–1939	317	40	13
1940–1950	165	33	20
Total	889	224	25

<sup>(a)</sup> Books are only noted in the decade when the first edition was published.

examined. Where possible, all editions of each title were reviewed noting any changes to invalid recipes in later editions. Of these books, 224 (25%) included recipes specifically designed for consumption by people who are sick or convalescing, in a total of 433 different editions. In the period 1930–1950 a significantly lower proportion of the cookbooks (only 15%) included invalid cookery advice ( $\chi^2 = 46.9, P < 0.01$ ).

To examine further the decline in the presence of invalid cookery sections, Table 2 shows data from all the multi-edition cookbooks that were published beyond 1950 and identifies the date of the last edition with any such recipes. Some continued to publish invalid recipes unchanged in editions into the 1990s and beyond, probably as historical curiosities.<sup>28, 29</sup> However, 10 of the 13 titles had ceased including such sections by the 1970s and mostly they are absent from cookbooks after the 1950s. Certainly, some of the most popular books published in the 1950s and 1960s did not include any invalid cookery advice.<sup>30–35</sup> Instead, there was a greater focus on including continental and Asian recipes in cookbooks after 1950.<sup>36</sup>

The annotated bibliography lists all the invalid cookery recipes in each of the 224 books.<sup>14</sup> More than half of the 1471 different recipes were for beverages (24%), desserts (21%) and soups (14%). All other categories were substantially smaller: meat and poultry dishes (9%), bread and cereals (8%), eggs, seafood and offal (6% each), vegetables and sauces (2% each) and sandwiches and salads (1% each). Table 3 lists the 50 most common recipes for invalids. Beef tea, barley water, gruel and meat broths top the list, with over 100 recipes each.

While modern menu planners would know the names of most of the recipes, several older dishes are probably unfamiliar today, including:

- Orgeat (a beverage made from barley or almonds)
- Panada (bread soup with added lemon, wine or sugar)
- Caudle (a sweet drink thickened with egg yolks)
- Posset (milk curdled by wine or citrus juice)
- Arrowroot (milk thickened with arrowroot and sugar)

**Table 2** Multi-edition cookbooks containing an invalid cookery section, with editions published after 1950

Book title and reference	Year of publication	Number of editions	Last edition with an invalid cookery section
The WMU Cookery Book <sup>15</sup>	1894–1961	19	1944
The PMWU Cookery Book of Victoria <sup>16</sup>	1916–1973	8	1948
The Orange Recipe Gift Book <sup>17</sup>	1931–1960	6	1949
Manual of Domestic Art <sup>18</sup>	1929–1953	10	1951
The School of Mines Cookery Book <sup>19</sup>	1930–1958	5	1953
The Schauer Cookery Book <sup>20</sup>	1909–1956	11	1956
Hobart Cookery Book <sup>21</sup>	1908–1961	12	1961
The Commonsense Cookery Book <sup>22</sup>	1914–2013	15	1974
Central Cookery Book <sup>23</sup>	1930–1992	17	1976
Coronation Cookery Book <sup>24</sup>	1937–1978	14	1978
The Barossa Cookery Book <sup>25</sup>	1917–1992	31	1992
Green and Gold Cookery Book <sup>26</sup>	1924–1999	25	1999
The Golden Wattle Cookery Book <sup>27</sup>	1924–2005	36	2005

- Negus (a drink made of wine, often port, mixed with hot water, oranges or lemons, spices and sugar)
- Koumiss (a fermented milk drink)
- Parkin (oatmeal and flour cake)

Furthermore, there are many recipes that would rarely appear on modern menus, including: calf's foot jelly, albumen water, toast water, suet and milk, brain canapés, pigeon, spatchcock, sweetbreads and linseed tea.

*Feeding advice:* In addition to recipes, a smaller proportion of the books included advice about how best to feed invalids or those convalescing from illness. Some of this appears to be based on the advice of health professionals such as nurses<sup>37, 38</sup> or doctors,<sup>39–41</sup> but much of the material is quite general with an emphasis on safe preparation of food and service to tempt poor appetites. Common advice is listed in Table 4 along with citations to some of the cookbooks where it appears.

From the late 1890s, many books included advice and recipes about the use of 'peptonised' foods.<sup>73–75</sup> One example of such advice is:

*In severe illnesses the patient is often not able to digest food of any kind without some assistance. This is owing to lack of the digestive juices. Certain foods can be digested outside the body and the patient may be tided over a critical period. Thus it is easy to make milk, beef tea, gruel etc perfectly digestible. The foods may be either peptonised by the aid of 'peptonising powders', or pancreaticised by the assistance of 'liquor pancreaticus'.<sup>49</sup>*

## Discussion

It is interesting that the beginning of the decline of invalid cookery sections in cookbooks coincides with the beginning of the dietetic profession in Australia, in the 1930s.<sup>76</sup> The recipes may originally have been meant for the use of people at home who were geographically isolated from ready medical or nursing support and it is possible that the increasing availability of expert dietary advice from health professionals made information in cookery books less

necessary. At the same time, perhaps home nursing became less common, especially in rural areas, with the development of more local hospitals and better transport services after the Second World War.

There is no particularly noticeable change in the types of recipes recommended over the nine decades, suggesting perhaps that many authors continued to copy older references on the topic rather than presenting new information. The advice about feeding invalids is often identical in various texts and focuses primarily on the service of small dainty serves, avoidance of fat and heavy seasoning, and not bothering the patient with choices about the food they are to receive. The rules given in 1905 in *Principles of Practical Cookery for NSW school pupils*<sup>55</sup> are much the same as the advice given 40 years later in *The Victorian Country Women's Recipe Book 1945–1946*.<sup>57</sup>

None of the advice about invalid cookery in these books is for particular disease states and, aside from a very small number of recipes for diabetic dishes, they do not provide therapeutic nutrition advice. Of course, nutrition knowledge was somewhat rudimentary during much of this time period. The isolation and purification of vitamins spanned the period from 1916 to 1950<sup>77</sup> and very little of the invalid cookery advice mentions nutrition specifically. It was not possible to assess the nutritional adequacy of the recipes and advice, because very few books contain menu plans, but given the wide range of recipes it should have been possible to provide well-balanced meals using the recommended recipes.

However, it is notable that beverages dominate the recipe lists and, if this reflected the priority in feeding patients, achieving nutritionally adequate menus could have been problematic. Beverages for the sick were broadly divided into four types:<sup>78</sup>

- 1 Nourishing (e.g. milk, egg flips, cocoa, milk tea, gruel, soups)
- 2 Medicinal (e.g. rice water, apple water, toast water)
- 3 Refreshing (e.g. lemonade, fruit drinks, aerated water)
- 4 Stimulating (e.g. tea, coffee, beef tea and various patent essences and juices).

**Table 3** The 50 most common invalid recipes in the 224 books

<i>Recipe</i>	<i>Number of recipes</i>
Beef tea	181
Barley water	143
Gruel	118
Chicken broth	96
Mutton broth	88
Toast water	86
Lemonade	70
Arrowroot	66
Apple water	63
Egg flip	62
Raw beef tea	59
Rice water	58
Beef tea custard	46
Junket	46
Albumen water	39
Wine whey	38
Baked apple	36
Milk jelly	36
Quickly made beef tea	36
Boiled custard	34
Poached egg	34
Steamed fish	34
Linseed tea	31
Steamed egg	30
Calf's foot jelly	26
Egg nog	26
Omelette	26
Baked custard	25
Grilled fish	25
Whey	25
Blancmange	24
Boiled egg	24
Egg jelly	24
Beef essence	23
Grilled steak or chop	23
Invalid's jelly	23
Wine jelly	23
Sweetbreads	22
Savoury custard	21
Scalloped oysters	21
Albumenised milk	20
Scrambled egg	20
Bread and milk	19
Light bread pudding	19
Stewed fruit	19
Fried fish	18
Steamed custard	18
Tripe	18
Baked egg	17
Cup custard	17

Stimulating beverages were thought not to actually build up the body, but were 'invaluable as a tonic to weakened energies and nerves'.<sup>79</sup> Some beverages would have had minimal nutritional value. For example, rice water was

simply water strained from boiled rice, with some added flavouring and sugar; toast water was made by soaking toast in water, straining it and adding some lemon juice.

Beef tea recipes appear in almost every book, sometimes with up to four different methods of production.<sup>80</sup> Once regarded as highly nourishing for patients, several of the authors note that it is best regarded as a stimulant rather than a food.<sup>46, 73, 81</sup> Nonetheless a commercial peptonised version (Beefine) was still being sold in 1945 and promoted as 'proved for invalids ... invaluable for convalescents, affords relief to sufferers from indigestion and nerves ... tones up the system, enriches the blood, is appetising, delicious, refreshing and wholesome'.<sup>75</sup>

Offal recipes are common, many for raw liver dishes. Until the late 1940s, when vitamin B12 was synthesised, a diet including raw liver was the main mode of treatment for pernicious anaemia,<sup>40, 82</sup> so there are many recipes to incorporate it into sandwiches, drinks, pâtés and other dishes. The small number of recipes for vegetable dishes may simply reflect the assumption that preparation of these foods needed no special modification for invalids.

One topic where there is disagreement in the various books is the suitability of alcohol for invalids or convalescents. Some authors say it is strictly forbidden,<sup>27, 61</sup> while others note its beneficial effect as a digestive stimulant.<sup>40</sup> Certainly, there are many recipes given for rum or brandy combined with milk or eggs, as well as for mulled wine.

The common recommendation that invalids should not be bothered by asking them what they would like to eat (Table 4) was reflected in practice in many hospitals in the 1960s when it was argued that non-selective menus were more likely to be nutritionally appropriate.<sup>83</sup> Nowadays this seems out of touch with patient expectations to be able to make their own choices, which are reflected in modern guidelines for hospital foodservice.<sup>84</sup>

It is noteworthy that many of the principles of invalid cookery in these books are very similar to the requirements of the 'Light Diet', commonly used in Australian hospitals postoperatively until the 1980s,<sup>85, 86</sup> but largely absent from more evidence-based guidelines thereafter.<sup>87</sup>

While there have been studies of changing advice about food and health in Australia,<sup>36, 88-90</sup> they have largely focused on the messages for the general population rather than for the sick. One exception is Colin Bannerman who describes some typical invalid foods in his review of old Australian cookbooks.<sup>91</sup>

The recipes in these Australian cookbooks are similar to those in early books on invalid feeding in UK<sup>92, 93</sup> and USA.<sup>94, 95</sup> The authors of dietetic advice in the early years of the last century were aware of their limitations and acknowledged the need for flexibility to meet the needs of sick patients. As noted in one book by a fellow of the Royal College of Physicians and a professional cook:

*Drugs have their place, and, in our opinion, a most important place; but diet in all cases takes precedence. May we anticipate the critic, and add that a treatise in the present small compass cannot present the reader with dietetic*

**Table 4** Common advice about feeding invalids in the home

Advice	Examples	Sources
Requirements of invalids	The powers of digestion are always impaired during illness, care must be taken therefore that dishes served are of a digestible nature and thoroughly cooked	42–45
	Food for invalids, or very sick persons, should be light, nourishing, and easy of digestion	27, 46–48
	As a rule, never ask a patient what he would like; so few can bear this. Rather bring a tasty, little meal as a surprise	46, 49–51
Meal service	Serve everything in small quantities, appetising in appearance, and scrupulously clean	46, 52, 53
	Ingredients should be perfectly fresh and of best quality	27, 46, 54
	Arrange all food as daintily as possible to induce appetite	27, 54, 55
	All hot dishes should be really hot and cold dishes quite cold	46, 53, 56
	Do not serve warmed-up food to an invalid. Everything but broths should be freshly cooked	57–59
Cooking methods	Remove all traces of food immediately a meal is finished and never present food a second time that the patient has once refused	27, 46, 55, 60
	Prepare foods preferably by steaming or stewing; frying is to be avoided except when convalescence is advanced	45, 53, 61, 62
	Remove every particle of fat from broths, soups, or beef tea with white kitchen paper or blotting paper	27, 46, 55, 61
	Avoid over-flavouring or over-seasoning food. Salt and pepper and spices of all sorts must be used with extreme caution	27, 53, 55
	Use no acids in jellies or drinks except lemon juice	60, 63, 64
	If a pudding is allowed, it must be light and digestible. Use no soda, acid or baking powder	56, 63, 64
	Food choices	Certain foods, such as pork, veal, the richer kinds of fish and pastry, must not be given
Milk contains all the necessary food constituents, and is therefore the perfect invalid's food. When milk is too heavy and causes indigestion, give half milk and half soda water		60, 63, 64, 67
Oysters are most easily digested when served raw		61, 68, 69
Gelatine and starchy foods, except as a way of conveying the wine or milk or eggs, contain very little nourishment		63, 70, 71
Mutton is slightly less nourishing than beef but is more easily digested		42, 68, 72
Fish, being light and easily digested, plays an important part in invalid diet. Whiting, sole, flounder or plaice should be selected, as these contain a very small percentage of oily matter		49, 68, 73
Boiled milk with a tablespoon of brandy to every half-pint is a good restorative and much easier digestion than raw milk		46, 52, 70

*intricacies, not to say eccentricities, but must restrict itself to teachings which have a more general currency. If these fail, the diet must be changed unhesitatingly and the organism humoured, however unorthodox or whimsical its tastes. The science of diet has yet to be written; till that time we must leave room for the eclecticism of the palate, and admit the fancy diet.*<sup>41</sup>

In summary, the advice about feeding invalids in early cookbooks provides a fascinating insight into one aspect of Australia's dietetic and culinary history. However, research questions remain about the sources and evidence base of the advice, how and where the recipes were used, and the roles of nurses and dietitians in the evolution of invalid feeding practice in Australia; this makes the topic worthy of further study.

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The author declares no conflicts of interest.

## Authorship

The author was solely responsible for the research design, data collection and analysis, and preparation of the manuscript.

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## ORIGINAL RESEARCH

# Risk of malnutrition is associated with poor physical function in patients undergoing cardiac rehabilitation following heart failure

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## Abstract

**Aim:** Patients who experience heart failure are prone to malnutrition. The aim of this study was to determine the association between risk of malnutrition and physical function in patients undergoing cardiac rehabilitation following heart failure.

**Methods:** A cross-sectional study was performed in consecutive patients hospitalised for cardiac rehabilitation following heart failure. Risk of malnutrition was evaluated using the Mini Nutritional Assessment-Short Form (MNA-SF). Physical function was evaluated using the Barthel index (BI). Univariate and multivariate analyses were used to determine whether nutritional status was associated with BI in these patients.

**Results:** The present study included 105 patients (mean age of 77.3 years, 56 men and 49 women) for analysis. The median (interquartile range) scores of the MNA-SF and BI were 11 (9–13) and 75 (45–90), respectively. Patients with high risk of malnutrition (MNA-SF score < 7) were significantly older, had a lower body mass index, exhibited lower muscle mass and strength, could walk shorter distances, and had lower BI scores (all  $P < 0.05$ ). On multivariate analysis, the MNA-SF score was independently associated with BI ( $\beta = 0.409$ ,  $P < 0.001$ ) after adjusting for age, sex, muscle mass and strength, brain natriuretic peptide levels, ejection fraction of the left ventricle, and reason for admission.

**Conclusions:** Risk of malnutrition is associated with physical function in patients undergoing cardiac rehabilitation following heart failure. Early detection of malnutrition and commencement of nutritional support may improve functional recovery in these patients.

**Key words:** elderly, heart failure, malnutrition, physical function, rehabilitation.

## Introduction

Patients who experience heart failure are prone to malnutrition. The prevalence of malnutrition, and those at risk of malnutrition, in patients with acute heart failure is 67%,<sup>1</sup> and 75%,<sup>2</sup> respectively. Furthermore, malnutrition was found in 60–69% of patients with chronic heart failure.<sup>3</sup> Impaired nutritional status in patients with heart failure increases the risk of mortality and re-hospitalisation.<sup>2–7</sup> In addition, low body weight is associated with poor clinical outcomes and high hospitalisation

rates in patients with heart failure, while obesity is associated with low mortality rate in these patients.<sup>8–10</sup> Therefore, early detection of malnutrition, and commencement of nutritional support if required, is crucial in the management of heart failure.

Cardiac rehabilitation involves a medically supervised program designed to help improve cardiovascular health. This program is recognised as an important component in the continuum of care for patients with cardiovascular disease, providing multidisciplinary education and effecting an exercise plan to improve morbidity and mortality risk.<sup>11</sup> Older adults undergoing rehabilitation in a hospital setting are often found to be malnourished,<sup>12,13</sup> with malnutrition associated with poor rehabilitation outcomes, such as impaired physical function and activities of daily living (ADL).<sup>14</sup> Therefore, it is essential to implement nutritional screening in all older patients undergoing rehabilitation. However, there is little evidence regarding the prevalence of malnutrition, and the subsequent impact on physical function or ADL, in cardiac rehabilitation patients following heart failure.

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The aim of this study was to determine the association between the risk of malnutrition and physical function in patients undergoing cardiac rehabilitation following acute heart failure.

## Methods

A cross-sectional study was performed between November 2016 and December 2017, in consecutive patients hospitalised for cardiac rehabilitation following heart failure. The study was conducted in Kagoshima City hospital with 166 acute care beds. Kagoshima City has a population of approximately 600,800 people, with 24.8% of individuals over 65 years of age. The mean number of patients admitted per month to cardiovascular wards at the hospital is 53, with a mean age of 78 years.

All patients with medically stable cardiovascular status admitted during the study period were included. The following patients were excluded: (i) those who needed artificial respiratory management, (ii) those who underwent cardiac catheter treatment, including revascularisation and (iii) those who presented severe symptoms. Catheter treatment was included in the exclusion criteria as it was considered that patients would require strict medical control for a period of time. The main reasons for admission included coronary artery diseases, cardiomyopathy, valvular diseases and hypertensive heart diseases.

Basic information was collected regarding patient characteristics, including age, sex, body mass index (BMI) (weight (kg)/height (m<sup>2</sup>)), reason for admission, premorbid ADL measured by the modified Rankin Scale (mRS),<sup>15</sup> actual feeding or swallowing status measured by the Food Intake Level Scale (FILS),<sup>16</sup> energy intake (kcal/kg/day), protein intake (g/kg/day), forced expiratory volume (FEV, %), forced vital capacity (FVC, %), brain natriuretic peptide (BNP, pg/mL) as an indicator of the severity of cardiac insufficiency and decline in cardiac function,<sup>17</sup> and resting energy expenditure (REE, kcal). As for dietary intake, nursing staff or dietitians recorded a visual estimate of the percentage of each item that the patient ingested. Registered dietitians then converted these results to estimate energy and protein intake. REE was recorded using an Aero Monitor AE-310S (Minato Medical Science Co., Ltd. Osaka, Japan) with the breath-by-breath method for 20 minutes in a resting bed in the early morning on an empty stomach, with the REE calculation formula of  $5.616 \cdot \text{Vo}_2$  (mL/min) +  $1.584 \cdot \text{V}_{\text{CO}_2}$  (mL/min).<sup>18</sup> Trained nurses assessed the anthropometric measurements and FILS, trained physical therapists and occupational therapists assessed arm circumference (AC), calf circumference (CC) and handgrip strength (HG), and a cardiovascular physician evaluated the degree of heart failure status using the New York Heart Association (NYHA).<sup>19</sup> AC and CC were measured on the non-dominant limb at the midpoint of the arm between the shoulder and the elbow and at the thickest part of the calf, respectively, using a standard tape technique: each patient was asked to sit on a chair or a

bedside and bend their elbow or knee at an angle of 90°, with their soles placed flat on the ground. We measured handgrip strength with the hand-grip test, using a Smedley hand-dynamometer (TTM, Tokyo, Japan) in the non-dominant hand (or in case of hemiparesis, in the non-paralysed hand), with the patient in a standing or seated position, depending on ability and with their arms straight at their side; the higher value from two measurements was recorded.

Nutritional status was assessed by the Mini Nutritional Assessment-Short Form (MNA-SF),<sup>20–22</sup> and BMI. Trained registered dietitians conducted interviews to assess the MNA-SF score. Patients were evaluated as at high risk of malnutrition when the MNA-SF score was <7 or BMI was ≤18.5 kg/m<sup>2</sup>, and as at low risk of malnutrition when the MNA-SF was >8 or BMI was >18.5 kg/m<sup>2</sup>. A BMI <18.5 kg/m<sup>2</sup> is used as an indicator of malnutrition in Asian countries, including Japan. This has been validated by many reports suggesting that low body weight with a BMI <18.5 kg/m<sup>2</sup> may be a risk factor for disease onset or mortality in Asian populations.<sup>23–26</sup>

The primary outcome, ADL as physical function, was assessed using the Barthel index (BI).<sup>27</sup> The BI is often used as an indicator of ADL in clinical practice and consists of an ordinal assessment (0–100 point), with lower scores indicating poor physical function.

The secondary outcome included walking distance (m), used as an indicator of walking ability. The patients were asked to walk at their usual speed without resting and were allowed to use canes or handrails as necessary. Patients were assisted by a physical therapist if unable to walk on their own.

Data from our previous study,<sup>28</sup> were extracted to determine the required sample size. In our previous study,<sup>28</sup> the BI score of patients admitted to hospital was normally distributed with a standard deviation of 19.5. If the true difference in means between patients with high or low risk of malnutrition is 10, a sample size of more than 51 would be needed in each group to reject the null hypothesis, with a power of 0.8 and an alpha error of 0.05. As such, data were collected for greater than 1 year to obtain a minimum of 51 patients in each group for the present study.

We used IBM SPSS Statistics 23 software (Armonk, New York) to perform statistical analyses. Parametric data were expressed as the mean (SD), and non-parametric data were reported as the median and 25–75 percentile (interquartile range, IQR). The  $\chi^2$  test, Mann–Whitney *U*-test, and *t*-test were used to analyse the differences between patients according to nutritional status. Multiple linear regression analysis was used to determine whether the risk of malnutrition was independently associated with the BI score. Covariates selected to adjust for bias included sex, age, reason for admission, AC, HG, BNP and MNA-SF. Furthermore, a multiple linear regression analysis was used to determine whether BMI on admission was independently associated with the BI score. Covariates selected to adjust for bias included sex, age, reason for admission, AC, HG and BNP. *P*-values less than 0.05 were considered statistically significant.

The present study was performed according to the ethical recommendations outlined in the Declaration of Helsinki. The ethics committee of the Kagoshima Medical Association Hospital approved this study (ethics code: 2016-2), and informed consent was obtained from patients or their legal guardians. Our manuscript complies with the Strengthening the Reporting of Observational Studies in Epidemiology to improve the quality of reporting.

## Results

The present study included 105 patients (mean age of 77.3 years, 56 men and 49 women) for analysis. In this study, heart failure was a result of coronary artery diseases (51 patients, 48.6%), cardiomyopathy (46 patients, 43.8%), valvular diseases (4 patients, 3.8%) and hypertensive heart diseases (4 patients, 3.8%). The haemodynamic status and general condition of all patients were considered to be medically stable, and no patients required intensive care during the study.

Table 1 shows the clinical differences between patients with high or low risk of malnutrition. Fifty-nine patients (56.2%) were considered to be at high risk of malnutrition based on their MNA-SF scores. The median (IQR) scores of the MNA-SF and BI were 11 (9–13) and 75 (45–90), respectively. Patients with a high risk of malnutrition (MNA-SF score < 7) were significantly older, had lower BMI, exhibited lower muscle mass and strength, walked shorter distances, had lower energy and protein intakes, and had lower BI scores (all,  $P < 0.05$ ) than patients who were at a low risk of malnutrition. Patients with low BMI ( $\text{BMI} \leq 18.5 \text{ kg/m}^2$ ) were significantly older, exhibited lower muscle mass and strength, had lower energy intakes and REE, and had lower MNA-SF scores (all  $P < 0.001$ ). BNP and the NYHA classification showed no significant difference between those with or without malnutrition, assessed by both the MNA-SF and BMI.

The results of the Spearman's correlation coefficients are shown in Table 2. Factors positively associated with the MNA-SF score included BI, CC, AC, HG, BMI, FILS, walking distance, energy and protein intake, and REE. Of these, BI had the strongest positive association with the MNA-SF score. Factors negatively associated with the MNA-SF score were age and mRS; mRS had a stronger negative association with MNA-SF.

Table 3 shows the results of multiple regression analyses for BI, adjusted for potential confounders. In a multiple regression analysis using the MNA-SF score as an independent variable of nutrition, the MNA-SF score was independently associated with BI ( $\beta = 0.409$ ,  $P < 0.001$ ). When BMI was used as an independent variable of nutrition in a multiple regression analysis, BMI was not independently associated with BI (Table 4). Both multivariate analyses were adjusted for age, sex, muscle mass and strength, BNP, ejection fraction of the left ventricle, and the reason for admission.

## Discussion

This cross-sectional study examined the association between the risk of malnutrition and physical function in cardiac rehabilitation inpatients following heart failure. We identified two important clinical findings. First, high risk of malnutrition was identified in over 50% of patients undergoing cardiac rehabilitation. Second, in these patients, the MNA-SF score was an independent risk factor for declining physical function.

In the present study, patients with a high risk of malnutrition were significantly older, had lower body weight and lower muscle strength, and had poorer physical function than patients with a low risk of malnutrition. Multiple factors are assumed to influence nutritional status in patients with cardiovascular diseases, including hypermetabolic status due to an elevated inflammatory response in heart failure, and a reduced energy and protein intake due to an overall decline in oral intake. These factors lead to a reduction in skeletal muscle mass, or loss of body weight, and further exacerbation of malnutrition.<sup>29,30</sup>

Indeed, in the present study, patients with a high risk of malnutrition, as assessed by the MNA-SF exhibited lower intakes of energy and protein. The aetiology of malnutrition in adults is varied, involving hunger-related, chronic disease-related and acute disease or injury-related malnutrition.<sup>30</sup> Therefore, in patients with heart failure, malnutrition could be caused or exacerbated by acute or chronic heart failure, inflammation, decreased oral intake, and low activity level. In the present study, while a causal relationship was unclear because of the nature of the study design, malnutrition was associated with low skeletal muscle mass and muscle strength and decreased physical function (sarcopenia).

Decreased physical function has been reported to be independently associated with malnutrition.<sup>31,32</sup> Similarly, in the present study, the MNA-SF score was found to be an independent risk factor for decreased physical function in cardiac rehabilitation patients following heart failure. This can be attributed to a decrease in whole-body durability caused by heart failure-related decline in cardiopulmonary capacity, in addition to the loss of muscle mass and strength caused by malnutrition. While it is well known that cardiac rehabilitation improves cardiopulmonary capacity and, therefore, whole body durability, nutritional support ensuring adequate intake of energy and protein, may maximise physical function in patients undergoing cardiac rehabilitation. It is, therefore, assumed that early detection of malnutrition can help to promote timely nutritional support to enhance functional recovery in these patients.

The present study has some limitations. First, this observational study involved a small sample size and was conducted in a single acute-care centre, possibly limiting the generalisation of the results. Second, the effect of various interventions, such as cardiac rehabilitation treatment and nutrition support during hospitalisation, was not investigated. Third, the MNA-SF is a measure of nutritional screening, not an indicator of nutritional status/malnutrition, for older adults aged over 65 years. The present study

**Table 1** Characteristics of patients with high or low risk of malnutrition assessed by the MNA-SF and low BMI

	Total (N = 105)	High risk of malnutrition (N = 59)	Low risk of Malnutrition (N = 46)	P-value	With low BMI (N = 20)	Without Low BMI (N = 85)	P-value
Age, years, mean (SD)	77.3 (12.6)	81.1 (11.4)	72.6 (12.7)	<0.001 <sup>(a)</sup>	80.7 (11.9)	76.5 (12.7)	0.186 <sup>(a)</sup>
Sex, n (%)				<0.001 <sup>(b)</sup>			<0.001 <sup>(b)</sup>
Male	56 (53.3)	23 (41.1)	33 (58.9)		4 (7.1)	52 (92.9)	
Female	49 (46.7)	36 (73.5)	13 (26.5)	0.617 <sup>(b)</sup>	16 (32.7)	33 (67.3)	0.726 <sup>(b)</sup>
Reasons for admission, n (%)							
Coronary artery disease	51 (48.6)	31 (60.8)	20 (39.2)		9 (17.6)	42 (82.4)	
Cardiomyopathy	46 (43.8)	23 (50.0)	23 (50.0)		10 (21.7)	36 (78.3)	
Valvular disease	4 (3.8)	3 (75.0)	1 (25.0)		0 (0.0)	4 (100.0)	
Hypertensive heart disease	4 (3.8)	2 (50.0)	2 (50.0)	0.580 <sup>(b)</sup>	1 (25.0)	3 (75.0)	0.672 <sup>(b)</sup>
NYHA, n (%)							
II	28 (26.7)	18 (30.5)	10 (21.7)		4 (20.0)	24 (28.2)	
III	61 (58.1)	32 (54.2)	29 (63.1)		12 (60.0)	49 (57.6)	
IV	16 (15.2)	9 (15.3)	7 (15.2)		4 (20.0)	12 (14.2)	
BMI, kg/m <sup>2</sup> , median (SD)	22.4 (5.0)	21.0 (5.3)	24.0 (4.1)	0.002 <sup>(a)</sup>	—	—	—
MNA-SF, score [IQR]	11.0 [9.0–13.0]	—	—	—	9.0 [6.3–10.0]	12.0 [10.0–13.0]	<0.001 <sup>(c)</sup>
CC, cm, median [IQR]	30.0 [28.0–34.0]	29.0 [26.0–31.5]	31.0 [28.5–35.3]	0.012 <sup>(c)</sup>	24.8 [20.6–28.0]	30.1 [28.5–34.3]	<0.001 <sup>(c)</sup>
AC, cm, median [IQR]	24.0 [20.2–26.0]	22.0 [20.0–24.5]	24.9 [21.9–28.0]	0.008 <sup>(c)</sup>	18.0 [15.5–21.0]	24.5 [22.0–27.3]	<0.001 <sup>(c)</sup>
HG, kg, median [IQR]	17.0 [8.0–26.5]	10.8 [7.5–18.8]	23.0 [14.8–29.3]	0.002 <sup>(c)</sup>	9.0 [6.1–17.5]	19.0 [8.8–27.8]	0.013 <sup>(c)</sup>
BI, score, median [IQR]	75.0 [45.0–90.0]	62.5 [41.3–80.0]	87.5 [75.0–100.0]	<0.001 <sup>(c)</sup>	62.5 [22.5–87.5]	75.0 [47.5–90.0]	0.150 <sup>(c)</sup>
mRS, score, median [IQR]	2.0 [1.0–3.0]	2.0 [1.0–4.0]	1.0 [1.0–2.0]	<0.001 <sup>(c)</sup>	9.0 [8.0–9.8]	2.0 [1.0–2.0]	0.058 <sup>(c)</sup>
Walking distance, m [IQR]	20.0 [9.5–70.0]	12.5 [0.0–30.0]	50.0 [27.5–200.0]	<0.001 <sup>(c)</sup>	9.5 [0.0–45.0]	20.0 [10.0–100.0]	0.025 <sup>(c)</sup>
FILS, score [IQR]	9 [9–10]	9 [8–9]	9 [9–10]	0.005 <sup>(c)</sup>	9 [8–10]	9 [9–10]	0.165 <sup>(c)</sup>
Energy intake, kcal/kg/day [IQR]	29.2 [24.1–33.4]	29.0 [23.8–32.8]	29.4 [24.5–33.8]	0.907 <sup>(c)</sup>	26.8 [22.3–31.4]	29.8 [24.7–34.8]	0.091 <sup>(c)</sup>
Protein intake, g/kg/day [IQR]	1.2 [1.0–1.5]	1.2 [0.9–1.5]	1.2 [1.0–1.5]	0.452 <sup>(c)</sup>	1.1 [0.8–1.5]	1.2 [1.0–1.5]	0.156 <sup>(c)</sup>
EF, (%) [IQR]	52.0 [33.5–65.0]	52.0 [32.3–63.0]	50.5 [33.8–66.3]	0.874 <sup>(c)</sup>	52.0 [32.3–63.8]	51.0 [34.0–65.5]	0.662 <sup>(c)</sup>
BNP, pg/mL, median [IQR]	652.2 [360.3–1061.9]	659.4 [490.2–997.7]	642.4 [272.6–1161.8]	0.969 <sup>(c)</sup>	685.1 [546.6–1096.2]	601.0 [334.2–1161.6]	0.346 <sup>(c)</sup>
REE, (kcal) [IQR]	1050.5 [811.8–1272.8]	1096.3 [872.5–1244.6]	1204.0 [1057.3–1382.0]	<0.001 <sup>(c)</sup>	813.5 [586.0–913.0]	1136.5 [870.8–1328.5]	<0.001 <sup>(c)</sup>
FEV, (%) [IQR]	1.3 [0.0–2.2]	0.8 [0.1–1.8]	1.6 [0.0–2.5]	0.075 <sup>(c)</sup>	0.7 [0.0–1.7]	1.4 [0.0–2.3]	0.069 <sup>(c)</sup>
FVCl, (%) [IQR]	1.4 [0.0–2.2]	1.2 [0.1–2.1]	1.8 [0.0–2.3]	0.076 <sup>(c)</sup>	1.0 [0.1–1.6]	1.6 [0.0–2.2]	0.102 <sup>(c)</sup>

<sup>(a)</sup> t-test.<sup>(b)</sup>  $\chi^2$  test.<sup>(c)</sup> Mann-Whitney U-test.

AC, arm circumference; BI, Barthel index; BMI, body mass index; BNP, brain natriuretic peptide; CC, calf circumference; EF, ejection fraction; FEV, forced expiratory volume; FILS, Food Intake Level Scale; FVCl, forced vital capacity; HG, handgrip strength; IQR, interquartile range; MNA-SF, Mini Nutritional Assessment-Short Form; mRS, modified Rankin Scale; NYHA, New York Heart Association; REE, resting energy expenditure.

**Table 2** Spearman's rank correlation coefficients for factors associated with the MNA-SF score

	MNA-SF	Age	BI	CC	AC	HG	BMI	FILS	mRS	Walking distance	REE	EF	BNP	Energy	Protein	NYHA
MNA-SF	1															
Age	-0.480**	1														
BI	0.549**	-0.560**	1													
CC	0.380**	-0.450**	0.246*	1												
AC	0.426**	-0.465**	0.231*	0.761**	1											
HG	0.401**	-0.485**	0.517**	0.321**	0.417**	1										
BMI	0.426**	-0.381**	0.243*	0.621**	0.665**	0.219*	1									
FILS	0.433**	-0.571**	0.640**	0.365**	0.341**	0.453**	0.275**	1								
mRS	-0.507**	0.606**	-0.570**	-0.369**	-0.351**	-0.420**	-0.251**	-0.585**	1							
Walking distance	0.544**	-0.474**	0.629**	0.210*	0.238*	0.538**	0.186	0.524**	-0.534**	1						
REE	0.522**	-0.570**	0.428**	0.468**	0.510**	0.353**	0.484**	0.409**	-0.468**	0.360**	1					
EF	-0.080	0.289**	-0.158	-0.145	-0.093	-0.121	0.071	-0.354**	0.296**	-0.044	-0.014	1				
BNP	0.053	0.088	-0.075	-0.097	-0.053	0.048	-0.254**	0.028	0.013	-0.068	-0.203*	-0.424**	1			
Energy	0.005	-0.119	-0.081	0.293**	-0.026	-0.126	0.023	-0.083	0.062	-0.104	0.105	-0.041	0.041	1		
Protein	0.043	0.119	-0.019	-0.095	0.013	-0.031	0.000	0.000	0.063	-0.025	0.036	-0.121	0.137	0.788**	1	
NYHA	0.096	-0.133	-0.006	0.028	-0.051	-0.064	-0.064	0.029	-0.033	-0.077	-0.134	-0.197*	0.251**	-0.022	-0.070	1

\*  $P < 0.05$ .

\*\*  $P < 0.01$ .

AC, arm circumference; BI, Barthel index; BMI, body mass index; BNP, brain natriuretic peptide; CC, calf circumference; EF, ejection fraction; FEV, forced expiratory volume; FILS, Food Intake Level Scale; FVCl, forced vital capacity; HG, handgrip strength; MNA-SF, Mini Nutritional Assessment-Short Form; mRS, modified Rankin Scale; NYHA, New York Heart Association; REE, resting energy expenditure.

**Table 3** Multiple regression analysis for Barthel index with the MNA-SF used as an independent variable of nutrition

	B	SE	95% CI or B	$\beta$	P-value
Age	-0.549	0.234	-1.010, -0.085	-0.229	0.021
Sex	2.657	5.509	-8.282, 13.596	0.044	0.631
AC	-1.089	0.508	-2.098, -0.080	-0.193	0.035
HG	0.666	0.231	0.208, 1.124	0.272	0.005
BNP	-0.006	0.004	-0.014, 0.002	-0.134	0.140
EF	-0.100	0.170	-0.438, 0.237	-0.057	0.556
MNA-SF	4.742	1.065	2.627, 6.857	0.409	<0.001
Coronary artery disease	5.651	4.972	-4.221, 15.524	0.094	0.259
Valvular disease	21.699	12.673	-3.464, 46.861	0.138	0.090
Hypertensive heart disease	-2.809	12.723	-28.070, 22.452	-0.018	0.826

$R^2 = 0.688$ ,  $P < 0.05$ .

AC, arm circumference; BNP, brain natriuretic peptide; EF, ejection fraction; HG, handgrip strength; MNA-SF, Mini Nutritional Assessment-Short Form.

**Table 4** Multiple regression analysis for Barthel index with BMI used as an independent variable of nutrition

	B	SE	95% CI or B	$\beta$	P-value
Age	-0.889	0.268	-1.421, -0.357	-0.370	0.001
Sex	8.791	5.875	-2.874, 20.456	0.145	0.138
AC	-0.660	0.631	-1.913, 0.594	-0.117	0.299
HG	0.729	0.258	0.216, 1.242	0.298	0.006
BNP	-0.003	0.004	-0.012, 0.006	-0.062	0.532
EF	0.019	0.188	-0.354, 0.392	0.011	0.919
BMI	-0.038	0.687	-1.402, 1.327	-0.006	0.957
Coronary artery disease	5.471	5.471	-5.392, 16.334	0.091	0.320
Valvular disease	15.322	13.911	-12.299, 42.944	0.097	0.274
Hypertensive heart disease	-0.089	13.987	-27.860, 27.682	-0.001	0.995

$R^2 = 0.602$ ,  $P < 0.05$ .

AC, arm circumference; BMI, body mass index; BNP, brain natriuretic peptide; EF, ejection fraction; HG, handgrip strength.

included some adults under the age of 65. Hence, there is a possibility of reduced reliability in nutrition screening. For a more accurate diagnosis of malnutrition, we should use the MNA full version for patients aged over 65 years. Fourth, we did not use validated tools to assess dietary intake. Fifth, a causal relationship between nutritional status and physical function was unclear due to the study design. Therefore, multicentre, high-quality, observational and interventional studies are needed to verify that early detection of malnutrition and appropriate nutritional support enhances the recovery of not only the nutritional status, but also the physical function of patients following heart failure.

The risk of malnutrition is associated with physical function in patients undergoing cardiac rehabilitation following heart failure. Early detection of malnutrition can help to promote nutritional support to improve functional recovery in those patients. However, further studies are needed to validate our findings.

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## Conflict of interest

The authors declare that they have no conflict of interest.

## Authorship

HM and YY had full access to the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis, including and especially any adverse effects; SF and YM contributed to the concept and design, data analysis, data interpretation and drafting the manuscript. All authors revised the manuscript critically for important intellectual content and approved the final version of the manuscript.

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## ORIGINAL RESEARCH

# Increased chewing reduces energy intake, but not postprandial glucose and insulin, in healthy weight and overweight young adults

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### Abstract

**Aim:** This randomised cross-over design study aimed to investigate different chewing activities between healthy weight and overweight individuals and to determine the effect of chewing on energy intake and postprandial plasma glucose and insulin concentrations.

**Methods:** Forty-one participants were classified into healthy weight and overweight groups according to body mass index (BMI). In Phase I, bite size (g/bite), bite rate (bites/minutes), chewing frequency (chews/minutes) and chews (chews/g food) were recorded after a sandwich breakfast. In Phase II, the mass of a sandwich consumed after 15 and 50 chews per bite (results of Phase I) was recorded. Postprandial plasma glucose and insulin were also examined at 0 (baseline), 30, 60, 90, 120 and 180 minutes.

**Results:** The results showed that the number of chews per bite was higher in lean participants as compared to overweight participants. Energy intake was highest in overweight participants who chewed 15 times per bite. Additionally, participants consumed less energy after 50 chews regardless of their BMI status. The results also demonstrated that 50 chews per bite insignificantly increased plasma insulin concentrations at every time point in both lean and obese subjects. Insulin concentrations were not significantly changed at each time point regardless of the number of chews.

**Conclusions:** Overweight participants chewed less and ingested more calories. Chewing 50 times per bite could reduce caloric intake regardless of weight status, suggesting that slow eating via increased chewing may help to reduce energy intake during meals. However, chewing did not affect postprandial plasma glucose and insulin levels in healthy young adults.

**Key words:** bodyweight, caloric intake, chewing.

## Introduction

The increase in the prevalence of overweight and obese people raises a significant burden on health care costs and reduces the quality of life. According to the World Health Organization, obesity results from an imbalance of energy intake and energy expenditure.<sup>1</sup> In addition, excessive caloric intake is a well-known cause of obesity. Implementation

of multidisciplinary treatment strategies requires lowering caloric intake in individuals to create an energy balance.

Mastication (chewing) is the first significant step to reduce the particle size of food matrix before swallowing, which subsequently affects gut signalling and digestive and absorptive processes.<sup>2</sup> In addition, mastication stimulates salivation and enhances oro-sensory stimulation, which regulates food intake.<sup>3</sup> Thus, chewing may be associated with control of caloric consumption and subsequent weight alterations. Accumulating evidence indicates that a prolonged chewing duration or an increased number of chews per bite could suppress postprandial appetite and rate of consumption.<sup>4</sup> An increased number of chews could also modulate glycaemic response by influencing energy intake,<sup>2,5</sup> postprandial hunger,<sup>6</sup> satiety and appetite.<sup>6</sup> However, a difference in chewing behaviours between healthy weight and overweight individuals remains to be determined. A few studies reported that overweight and obese individuals eat faster and chew less than do healthy weight

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individuals.<sup>7,8</sup> However, other studies showed that slowing the speed of eating led to a significant reduction in energy intake in the normal weight but not overweight group.<sup>9</sup>

In addition, food particle size after chewing may influence plasma glucose and insulin concentrations.<sup>10</sup> Alterations of postprandial plasma glucose and insulin by chewing adjustment may benefit patients with metabolic syndromes or diabetes. Previous work has shown that an increased number of chews per portion increased plasma concentrations of glucose and insulin.<sup>6</sup> However, other studies showed no significant effects of chewing on postprandial plasma glucose and insulin.<sup>2</sup> Therefore, the effect of chewing on postprandial plasma glucose and insulin levels remains unknown. The current cross-sectional study first aims to investigate the differences in chewing activity between healthy weight and overweight participants. Second, the study aims to investigate the effects of the number of chews on energy intake, hunger, satiety, appetite, postprandial plasma glucose and insulin in both healthy weight and overweight participants. The results may provide potentially useful recommendations to promote the benefits of chewing for weight management and control of hyperglycaemia.

## Methods

After responding to an advertisement posted at the university and the nearby community, 45 participants (21 males, 24 females) between the ages of 18 to 50 met the inclusion criteria. A nurse and a registered dietitian screened participants for the inclusion criteria which included non-smoking; consumption of a regular breakfast; healthy teeth (a full set of healthy teeth); no food allergies; no eating disorders; less than 2-kg weight alteration over the past 3 months and no consumption of any medications or dietary supplements that may confound any study indicators. Eligible participants were divided into two groups (lean and overweight) according to their body mass index (BMI) (lean BMI ( $\text{kg}/\text{m}^2$ )  $\geq 18.5$  and  $< 23$ , overweight BMI  $\geq 23$ ).<sup>11</sup> Forty-one participants (17 males, 24 females) completed the study protocol. On the morning of the study day, anthropometry data for each participant was collected. BMI was calculated as  $\text{weight}/\text{height}^2$  (in kilograms per square meter). Waist and hip circumferences were measured to the nearest 1.0 cm using a standard rounded tape at a point right above the iliac crest on the mid-axillary line at minimal respiration (for waist) and in a horizontal plane at the level of the maximal extension of the buttocks (for hip).

All procedures involving human participants were approved by the Ethical Review Committee for Research Involving Human Research Subjects, Health Science Group, Chulalongkorn University, Bangkok, Thailand. Written informed consent was obtained from all participants prior to enrolment in the study. The anonymity of the participants was preserved. The Clinical Trial number was NCT03342313 (Clinicaltrial.gov).

*Phase I: investigate the differences in chewing activities between healthy weight and overweight participants.* In

Phase I, the day before the clinic visit, participants were requested to consume only fried rice with egg *ad libitum* for their dinner between 6:00 and 7:00 p.m. No other food or drinks were allowed after the provided dinner. The next morning, participants arrived at the clinic between 7:00 and 8:00 a.m. after a 12-hour overnight fast and a 24-hour period without exercise. A ham and cheese on white bread sandwich, which was the subjects' usual breakfast, with percentage caloric distributions of carbohydrate, protein and fat of 33.80, 7.82 and 48.38, respectively, was served with 300 mL of water for breakfast *ad libitum*. Each participant received a sandwich (110 g, 145 kcal) *ad libitum* in a separated room on a clinic day according to their appointment. Weight of the food consumed was recorded. A digital camera was positioned 2 m (face on) from the participants to record participant chewing activities, including meal time (minutes); timing at the first bite until the end of the last bite, bite size (gram/bite); weight of food eaten divided by bite number; bite rate (bite/minutes); bite number divided by minutes of meal time, chewing frequency (chews/minutes); chewing number divided by minute of meal time, chews (chews/g) and chewing number divided by gram of food eaten. The videos were interpreted by three researchers independently. The inter-observer reliability was examined using intraclass correlation (ICC).<sup>12</sup> The results showed that ICC for all measurements was reliable (ICC  $\geq 0.90$ ). Participants were informed that the objective of the present study was to examine the effect of solid food on postprandial blood glucose. The results show that the maximum and minimum number of chews per bite was 50 and 15 (mean  $\pm$  SD,  $50.80 \pm 15.24$ ,  $13.95 \pm 5.03$  chews per bite, respectively). The average number of chews was rounded up for convenience and used as a factor in Phase II of the study.

*Phase II: investigate the effects of chew number on energy intake, hunger, satiety, appetite, postprandial plasma glucose levels and insulin levels in both healthy weight and overweight participants.* In this randomised cross-over design study, participants were separated into two groups (15 chews/bite and 50 chews/bite) with 2 weeks of a wash-out period. The day before the clinic visit, participants were requested to consume only fried rice with egg *ad libitum* for their dinner between 6:00 and 7:00 p.m. No other foods or drinks were allowed after the provided dinner to prevent confounding factors of previous food consumption. The next day, participants arrived at the clinic between 7:00 and 8:00 a.m. after a 12-hour overnight fast and a 24-hour period without exercise. At the clinic, baseline characteristics including anthropometry, hunger, satiety, appetite and plasma glucose and insulin concentrations were collected before breakfast was served. Each participant was asked to rate their hunger, satiety and appetite using a visual analogue scale (VAS) questionnaire developed by Hill and Blundell.<sup>13</sup> Each VAS questionnaire was 100 mm in length and contained labels ranging from 'not at all' (score of 0) to 'extremely' (score of 10). After collection of baseline parameters, participants were served an *ad libitum* ham and cheese sandwich and 300-mL water for breakfast. In order to

control for bite size, a sandwich was cut into pieces of 7 g each (an average bite size of lean and overweight participants results from Phase I study) before served. Participants were required to finish their breakfast within 20 minutes after the first bite. The VAS questionnaire and blood samples of postprandial glucose and insulin were examined at 0 (baseline) 30, 60, 90, 120 and 180 minutes after the test meal. Blood was collected using indwelling catheters at specified time points and immediately centrifuged at  $2500 \times g$  at  $4^{\circ}\text{C}$  for 15 minutes. Aliquots of plasma were separated and frozen at  $-20^{\circ}\text{C}$  until glucose and insulin concentration analysis. Plasma glucose concentration was determined by the glucose oxidase method using an auto-analyser. Plasma insulin was determined using a chemiluminescence method at a Health Sciences service unit, Faculty of Allied Health Sciences, Chulalongkorn University. Additionally, the homeostatic model assessment of insulin resistance (HOMA-IR) was measured as fasting serum insulin ( $\mu\text{IU/mL}$ )  $\times$  fasting plasma glucose (mmol/L)/22.5. Energy intake was calculated using the plate waste (the mass of the food served minus the mass of the food left over). A digital camera recorded the number of chews per bite for each participant to endorse study compliance. Four participants (lean = 2, overweight =2) were excluded since they did not comply with the chewing number requirement of 15 and 50 times before swallowing according to the study protocol in Phase II. All data of these four participants were excluded from analysis.

All data are presented as the mean  $\pm$  SD. Student's *t*-tests were applied to determine differences between the means for baseline characteristics and chewing activities variables. Energy intake data was analysed by two-factor analysis of variance (ANOVA) (status  $\times$  chewing). The area under the curve (AUC) was calculated according to the trapezoidal rule to quantify the overall response to chewing. Postprandial plasma glucose levels, insulin levels and the AUC of the different tests were compared using analysis of variance with Bonferroni correction for multiple comparisons. A total sample size of 14 participants in both lean and overweight groups would provide 80% power to detect significant differences of chewing on energy intake in lean and overweight participants.<sup>2</sup> Differences were considered as statistically significant at a probability value (*P* value) of less than 0.05. All analyses were performed using SPSS, version 16.0 (IBM, Chicago, IL, USA).

This manuscript was written in accordance with the CONSORT (Consolidated Standards of Reporting Trials) guidelines.

## Results

Forty-one participants completed both phases of the present study. There was no significant difference in age, height and fasting plasma glucose between lean ( $n = 20$ ) and overweight ( $n = 21$ ) groups (Table 1). The mean weight, BMI, waist and hip circumferences, plasma insulin and HOMA-IR were all significantly greater in overweight participants ( $P < 0.001$ ).

**Table 1** Baseline anthropometric characteristics of lean and overweight participants

	Lean ( $n = 20$ ) (male = 9, female =11)	Overweight ( $n = 21$ ) (male = 8, female =13)
Age (years)	21.45 $\pm$ 1.32	20.76 $\pm$ 1.22
Height (cm)	163.60 $\pm$ 5.83	164.86 $\pm$ 9.14
Weight (kg)	55.25 $\pm$ 5.59	76.22 $\pm$ 16.94*
BMI ( $\text{kg/m}^2$ )	20.61 $\pm$ 1.49	27.88 $\pm$ 4.81*
Waist circumference (cm)	71.44 $\pm$ 5.08	91.20 $\pm$ 14.42*
Hip circumference (cm)	89.48 $\pm$ 3.85	106.53 $\pm$ 11.29*
Fasting plasma glucose (mg/dL)	77.14 $\pm$ 6.58	81.10 $\pm$ 7.49
Plasma insulin ( $\mu\text{IU/mL}$ )	4.02 $\pm$ 1.57	8.03 $\pm$ 3.94*
HOMA-IR	0.77 $\pm$ 0.35	1.60 $\pm$ 0.83*

All values are displayed as the mean  $\pm$  SD. \* Significantly different from lean participants,  $p < 0.001$ .

HOMA-IR, homeostatic model assessment of insulin resistance.

*Phase I: Investigate the differences in chewing activities between healthy weight and overweight participants.* Meal duration, bite size and bite rate were not significantly different between lean and overweight participants. However, chewing frequency and the number of chews per gram of food were higher in lean participants as compared to overweight participants ( $66.53 \pm 12.34$  vs  $57.33 \pm 11.72$ ,  $P = 0.019$  and  $4.26 \pm 1.28$  vs  $3.11 \pm 1.09$ ,  $P = 0.004$ , respectively) (Table 2). Correspondingly, the number of chews per bite was higher in lean participants than in overweight participants ( $P = 0.004$ ).

*Phase II: Investigate the effect of the number of chews (15 and 50) on energy intake, hunger, satiety, appetite, postprandial plasma glucose levels and insulin levels in both healthy weight and overweight participants.* Figure 1 shows that energy intake was highest in overweight participants who chewed 15 times per bite. Participants who chewed 50 times ingested less energy compared to participants who chewed 15 times, regardless of BMI status.

Paired-samples *t*-tests showed no significant differences in hunger, satiety and appetite after 15 chews in both lean and overweight participants at all-time points tested. However, the satiety VAS score was higher after 50 chews as compared to 15 chews in both lean and overweight participants at every time point. The hunger VAS score of the 50 chew group in lean and overweight participants was lower, but not significant, as compared to the 15 chew group at every time point.

Figure 2a showed that plasma glucose levels peaked 30 minutes after the test meal in both lean and overweight participants, regardless of the number of chews. As compared to lean participants, plasma glucose was higher but not significantly, in overweight participants at every time point. Regardless of their BMI, participants who chewed

**Table 2** Differences in chewing activity between lean and overweight participants

	Lean (n = 20) (male = 9, female = 11)	Overweight (n = 21) (male = 8, female = 13)
Meal time (minutes)	11.90 ± 4.19	10.58 ± 5.60
Bite size (g/bite)	7.10 ± 1.18	7.26 ± 1.75
Bite rate (bites/minutes)	2.43 ± 0.82	2.80 ± 0.87
Chewing frequency (chews/minutes)	66.53 ± 12.34	57.33 ± 11.72*
Chews (chews/g food)	4.26 ± 1.28	3.11 ± 1.09*
Energy intake (kcal)	517.16 ± 137.60	565.38 ± 194.89*
Minimum chews per bite	14.55 ± 7.87	13.95 ± 5.03*
Maximum chews per bite	50.80 ± 15.24	40.81 ± 12.05*

All values are presented as the mean ± SD.

\*Significantly different from lean participants,  $P < 0.05$ .

50 times demonstrated a higher, but not significantly, plasma glucose concentration as compared to those who chewed 15 times at almost every time point. Similar to the plasma glucose results, plasma insulin also peaked 30 minutes after the test meal. The results also showed that chewing 50 times per bite insignificantly increased plasma insulin concentrations at every time point in both lean and obese participants (Figure 2b).

## Discussion

In our current study, we demonstrated that overweight participants chew less than healthy weight participants. Additionally, chew frequency, the number of chews per gram of food, and the number of chews per bite were all decreased in overweight participants. Previous studies have investigated the differences in chewing activity between healthy weight and overweight participants.<sup>2,9,14</sup> However, studies on this topic have been conflicting; some studies reported no significant differences in chewing activity between healthy weight and overweight participants.<sup>8,15</sup> However, other studies have demonstrated that overweight and obese participants chewed less (measured in number of chews/minutes and number of chews per gram of food) than healthy weight participants. Chewing less may increase energy intake and eventually lead to uncontrolled weight gain.<sup>7,8</sup> This finding is supported by a previous study that stated that *ad libitum* energy intake was higher when the meal was eaten too quickly.<sup>16</sup> We observed that overweight participants consumed more test food as compared to lean participants, which resulted in significantly increased caloric consumption.

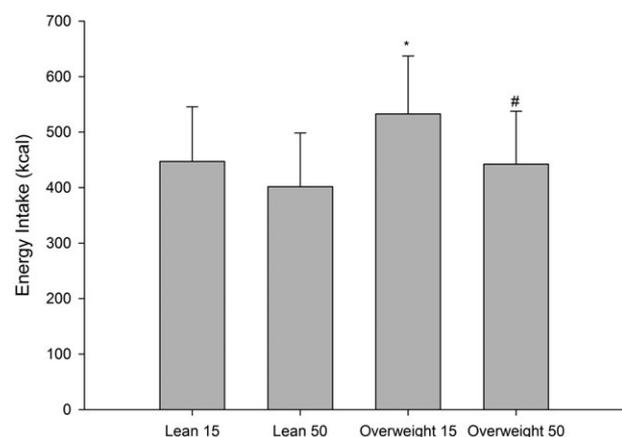
We demonstrated that participants consumed less energy after 50 chews per bite as compared to 15 chews per bite, regardless of their weight status. This result is similar to the finding of a previous study, which demonstrated that both lean and obese participants eat less when they chewed 40 times per bite as compared to 15 chews per bite.<sup>2</sup>

Furthermore, differences in the amount of time taken to eat a test meal and reduced chewing were previously reported in overweight and obese children<sup>17</sup> and morbid

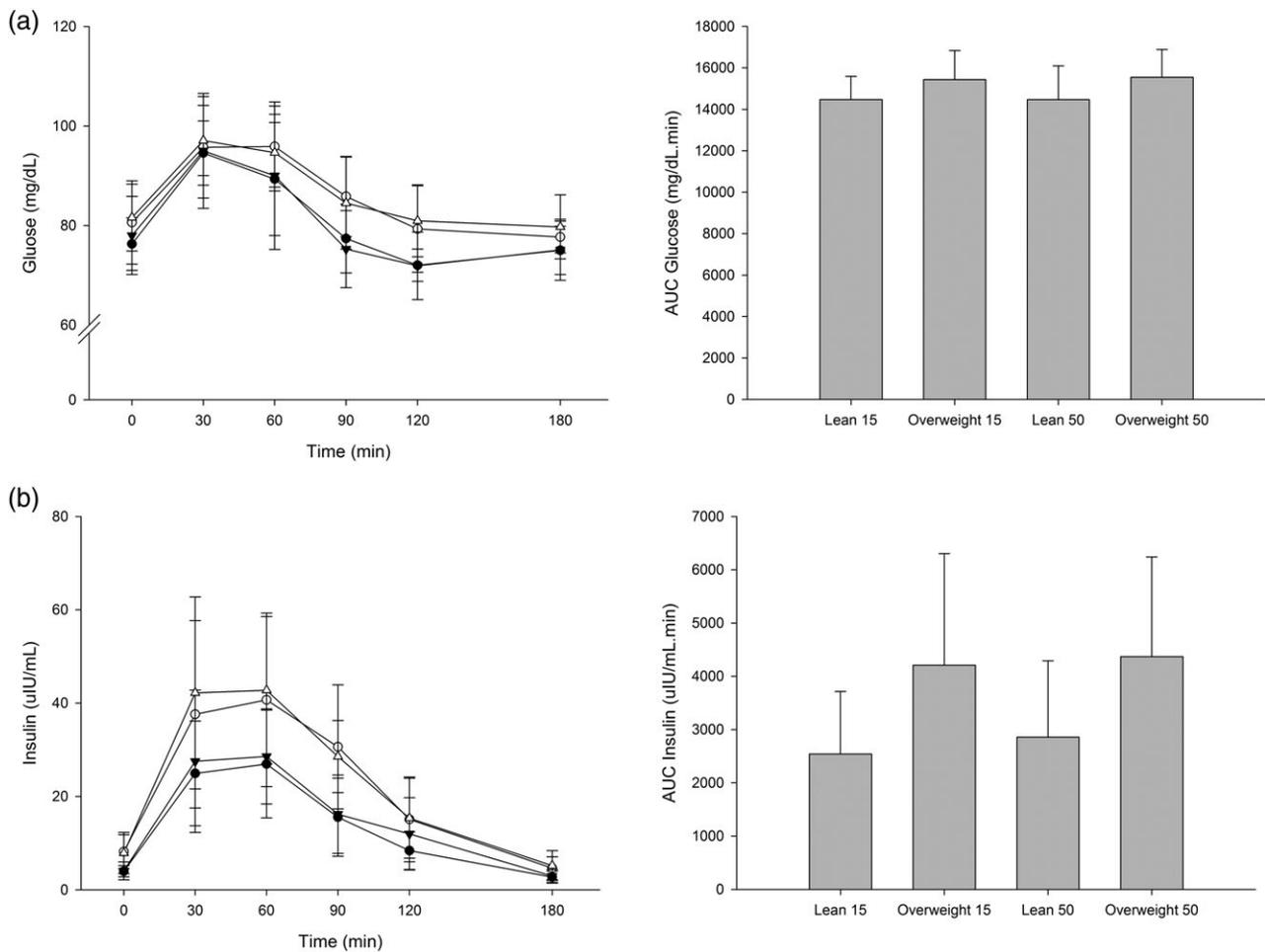
obesity patients.<sup>18</sup> It has been reported that an increase in the duration of oral processing or an increase in the number of chews per bite tended to accelerate satiety and subsequently meal termination via increase in retro-nasal aroma release.<sup>19</sup> However, there might be additional factors that contribute to this effect, including textures, fat content and test structure. Therefore, it is vital to consider those confounding factors in the study results.

In the present study, we found no significant differences in hunger, satiety and appetite on the VAS scale after 15 and 50 chews in both lean and overweight groups at every time point. Food intake at dinner, the day before the study, was controlled to minimise the carry over effect of dinner on the study. Therefore, over feeding in lean and under feeding in overweight subjects may have affected this VAS. Serving a dinner and test meal according to the caloric needs of individual participants may eliminate or at least minimise these limitations in a further study.

In the present study, our results showed that overweight participants had insignificantly higher levels of both fasting plasma glucose and insulin; however, postprandial glucose and insulin concentrations at every time point were not



**Figure 1** Mean ± SD energy intake after 15 and 50 chews in lean (n = 20) and overweight (n = 21) participants. \*Significantly different from the lean, 15 chew group. #Significantly different from the lean, 50 chew group.



**Figure 2** Mean  $\pm$  SD postprandial plasma glucose concentrations. The area under the glucose curve (a) and postprandial plasma insulin concentrations and the area under the insulin curve (b) after 15 and 50 chews in lean ( $n = 20$ ) and overweight ( $n = 21$ ) participants at 0 (baseline), 30, 60, 90, 120 and 180 minutes after the test breakfast.

significantly different. Although mastication has the potential to affect postprandial plasma glucose concentrations by improving digestibility and absorption of nutrients,<sup>20</sup> our results demonstrated that the number of chews did not influence postprandial plasma glucose and insulin levels. We assumed that since our participants were healthy young adults without any metabolic diseases, their homeostatic systems might overcome the effects of mastication on glucose and insulin. To our knowledge, healthy young individuals should be able to control their postprandial plasma glucose and insulin after a moderate glycaemic load without significant alterations in hyperinsulinaemic response or fluctuations in glycaemia.<sup>21</sup>

A possible limitation of the present study was that a result from single meal study with controlling for consuming time may not be extrapolated to predict effects of chewing on energy intake over the long term. Moreover, the present study was conducted in a metabolic kitchen, so, the condition and atmosphere could be different from the usual habit. Even though a sandwich is the usual breakfast for the majority of participants, it might not be a favourite

breakfast to all participants. We also considered that not all food textures would require similar amount of chewing. Therefore, these results might not be generalised to other population groups and different food texture.

In addition, there are more factors including age, race and ethnicity which play an important role to control eating behaviours. Despite these limitations, the present study concluded that overweight participants chewed less, which may result in increased caloric consumption. Chewing 50 times per bite could reduce caloric intake regardless of weight status. In addition, chewing did not influence postprandial plasma glucose and insulin in healthy young adults. Although more research is needed to warrant these results, our data suggest that eating more slowly by chewing more may help to reduce energy intake within meals.

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## Conflict of interest

The author(s) declare no potential conflicts of interest with respect to the research, authorship and/or publication of this article.

## Authorship

Montinee Borvornparadorn, Vasana Sapampai, Chunya Champakerdsap and Wipawee Kurupakorn were responsible for recruitment of volunteers, data collection and interpretation of the results. Suwimol Sapwarobol was responsible for study concept and design and supervised the study, performed a critical revision of the manuscript for important intellectual content and contributed to the writing of the final manuscript. All authors critically reviewed the manuscript and approved the final version submitted for publication.

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**ORIGINAL RESEARCH**

# Relationship between long-chain omega-3 polyunsaturated fatty acid intake and ankle brachial index, pulse wave velocity and resting heart rate in a sample of overweight adults: A secondary analysis of baseline data in the HealthTrack study

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**Abstract**

**Aim:** The present study aimed to explore the association between dietary long-chain omega-3 polyunsaturated fatty acid (LCn3PUFA) intake and cardiovascular risk indicators (ankle brachial index, resting heart rate and brachial-ankle pulse wave velocity) in a clinical sample of overweight and obese participants volunteering for a weight loss trial.

**Methods:** This was a secondary analysis of baseline data from the HealthTrack study ( $n = 351$ ). LCn3PUFA intake was calculated via a diet history and the association with ankle brachial index, resting heart rate and brachio-ankle pulse wave velocity was explored using linear regression after controlling for covariates.

**Results:** LCn3PUFA intake was inversely associated with ankle brachial index ( $R^2$  change = 0.021,  $F$  change (1, 339) = 8.864,  $P < 0.05$ ) and resting heart rate ( $R^2$  change = 0.014,  $F$  change (1, 342) = 5.337,  $P < 0.05$ ) but not with brachio-ankle pulse wave velocity ( $R^2$  change = 0.001,  $F$  change (1, 339) = 0.725,  $P > 0.05$ ).

**Conclusions:** In this clinical sample of overweight adults, LCn3PUFA consumption was significantly associated with a lower resting heart rate, adding to the current evidence on the potential benefits of LCn3PUFA consumption. It also supports the value of targeting a diet rich in this nutrient when planning future dietetic approaches. Relationships with ankle brachial index and pulse wave velocity require further investigation. Future research should assess the effect of changes in dietary LCn3PUFA intake on novel cardiovascular risk indicators.

**Key words:** ankle brachial index, cardiovascular risk factors, diet history, LCn3PUFA, pulse wave velocity, resting heart rate.

**Introduction**

Cardiovascular disease (CVD) is considered to be a global health concern, responsible for 17.7 million deaths, which represented 31% of global deaths in 2015.<sup>1</sup> Exploring novel, non-invasive physiological risk factors for CVD provides insight into disease risk and progression and can be used to explore the effect of lifestyle modifications on CVD risk. Heart rate (HR), arterial stiffness and peripheral arterial disease (PAD) are now considered to be independently

associated with high risk of CVD.<sup>2–14</sup> Epidemiological studies have reported strong, independent, graded correlations between elevated resting HR and CVD.<sup>13,15</sup> Lower resting HR is associated with a lower CVD risk compared to increased HR.<sup>11,16</sup> In comparison, arterial stiffness is defined as a reduction of the distending ability of arteries due to pathological changes in the vessel wall. The ‘gold standard’ measurement of arterial stiffness is pulse wave velocity (PWV).<sup>17</sup> Increased stiffness or elevated PWV promotes endothelial damage and increases back-pressure to the left ventricle of the heart, causing left ventricular hypertrophy and coronary ischaemia, ultimately resulting in CVD.<sup>17,18</sup> Improving arterial stiffness (i.e. reducing PWV) aids CVD prevention and treatment in clinical practice.<sup>19,20</sup> PAD is the blockage or narrowing of medium to small arteries supplying limbs, mainly the lower extremities, and is primarily diagnosed by ankle brachial index (ABI) in clinical practice. The main cause of PAD is atherosclerosis.<sup>21–24</sup> Coexisting severe coronary atherosclerosis and similar

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lesions can be found elsewhere in the arterial system in patients with PAD or low ABI.<sup>2–5,25</sup> Investigation of modifiable factors which can impact these risk factors is required.

Dietary modifications may play a role in influencing physiological risk factors for CVD including those described above. The effect of consumption of long-chain omega-3 polyunsaturated fatty acids (LCn3PUFAs) on CVD has been studied extensively during the last few decades. LCn3PUFAs are a group of fatty acids abundant in oily fish and produced in minute amounts in the human body from desaturation of alpha-linolenic acid, which is an essential fatty acid.<sup>26,27</sup> Research suggests supplementation of LCn3PUFA may have CVD protective and mortality reduction effects by improving endothelial function, reducing CVD risk factors such as blood pressure, HR, and serum triglyceride levels, and reducing ventricular arrhythmias and chronic inflammation.<sup>28–37</sup> There is currently a paucity of evidence on the effects of dietary modification including LCn3PUFA intake on forms of CVD such as PAD. As a result, the body of evidence for the effects of LCn3PUFA consumption on risk factors including ABI remains inconclusive. While previous research has explored the relationship between LCn3PUFA intake and CVD risk factors, there has been a paucity of research investigating this relationship in the clinical context. Exploration of the relationship between consumption of LCn3PUFA and risk factors for CVD in a clinical sample provides an opportunity to investigate the relevance of this relationship in clinical practice. This also provides insight into potential dietetic strategies for improving CVD risk in clinical populations.

The present study aimed to explore the association between reported LCn3PUFA intake and cardiovascular risk indicators (ABI, resting HR and brachial-ankle PWV (baPWV)) in a sample of overweight and obese adults (25–54 years) volunteering for a clinical trial.

## Methods

The present study is a secondary analysis of baseline data on participants randomised to the HealthTrack study.<sup>38</sup> The HealthTrack study was a 12-month randomised controlled trial conducted in the Illawarra region, 70 km south of Sydney, Australia. Study subjects were overweight or obese (body mass index (BMI) 25–40 kg/m<sup>2</sup>) adults aged between 25 and 54 years. The HealthTrack study exclusion criteria included being unable to communicate in English; severe medical conditions which impaired the ability to participate in the study; immune deficiencies; survival from illnesses predicted to be less than 1 year; reported illegal drug use; regular alcohol intake associated with alcoholism (>50 g/day), or having difficulties or hindrances in participating for study components. From recruitment, 377 participants were randomised for baseline analysis, intervention and follow up. Randomised participants were grouped into three arms to examine the interdisciplinary approach of weight reduction with usual care. The primary outcome was weight and secondary outcomes included disease risk factors such as fasting blood lipids, glucose, HbA1c, systolic

blood pressure and behaviour (diet, activity and psychological factors).<sup>38</sup>

Ethical approval was obtained from the University of Wollongong/Illawarra Shoalhaven Local Health District Human Research ethical committee (Health and Medical) (HE 13/189) and the study was registered with the Australian and New Zealand Clinical Trial Registry (ANZCTRN12614000581662).

All physiological data were collected in a laboratory which was calm and quiet to minimise external stimulation. Participants were not fasted prior to the collection of physiological data. Resting HR, baPWV and ABI data were measured using an Omron BP-203RPEIII VP-1000 device (Omron Health Care, Kyoto, Japan) and cleaned using American Heart Association guidelines.<sup>37</sup> Measurements were taken following a 5-min resting period in the supine position. Two measurements were taken and the second was used as the actual measurement for the study. Blood pressure taken at the same time as the ABI measurement was utilised for the calculation of mean arterial blood pressure (MBP). The following equation was used to calculate MBP as a covariate for baPWV:<sup>39,40</sup>

$$MBP = \frac{\text{systolic pressure} + 2(\text{diastolic pressure})}{3}$$

PWV was cleaned according to the European Society of Cardiology guidelines.<sup>39</sup>

Dietary intake data were collected using diet history (DH) interviews conducted by a team of Accredited Practising Dietitians, using a validated interview protocol,<sup>41</sup> with support from food models and household measures. Dietary data were entered into FoodWorks nutrient analysis software (version 7.0, 2012 Xyris Software, Highgate Hill, Australia) using AUSNUT 2007.<sup>42</sup> Where a food item was not found in the AUSNUT 2007 database, an appropriate substitution was made, or if possible, a new product was created using label data. Where substitutions were required, a log of substituted products was kept to improve reliability, and all dietary data were checked by an independent researcher. Dietary intake of LCn3PUFA was then calculated. We have previously found reported intake of LCn3PUFA collected using this method to be associated with objective measures of LCn3PUFA intake.<sup>43</sup> LCn3PUFA intake was compared to the National Health and Medical Research Council Nutrient Reference Values Suggested Dietary Target (SDT) (males: 610 mg; females: 430 mg/day).<sup>44</sup> Detailed data on quantity and frequency of LCn3PUFA supplement consumption were not available, however, during the baseline assessment participants reported if they took supplements, and these data were used in the current analysis. Body weight (kg) and height were measured at the baseline to determine BMI. Weight was measured with participants in an upright position, with no shoes and minimal clothing (Tanita TBF-662, Wedderburn Pty Ltd., Ingleburn, Australia), with the height measured using a stadiometer.

During baseline screening, participants reported whether they had previously been diagnosed by a doctor with type 2 diabetes, CVD or hypertension. Fasting blood samples were collected by a registered pathological service (Southern IML Pathology) at baseline. Cholesterol/HDL ratio data was utilised in the current study because this measure has the greater predictive ability of atherosclerotic vascular disease than other blood cholesterol measurements and is less modified by LCn3PUFA intake.<sup>45,46</sup>

The International Physical Activity Questionnaire, a validated assessment tool for use in the Australian community, was used to assess participant's physical activity.<sup>47</sup>

Statistical analysis was conducted using SPSS (version 22.0, 2013, IBM Corp, New York, NY, USA). The distribution of all continuous data was explored for normality (Kolmogorov–Smirnov, Shapiro–Wilk and graph) and log-transformed if found to be non-parametric (LCn3PUFA—FR and DH, baPWV, ABI, resting HR, cholesterol/HDL ratio and total energy). Data which could not be transformed (age) were categorised into groups. All categorical data were arranged into binominal groups. Descriptive statistics of central tendency were calculated for all parameters. Results were presented with mean and standard deviation if variables were continuous and parametric, with median and interquartile range (25th and 75th percentile) reported if continuous variables were non-parametric. Categorical variables were presented as percentages.

Hierarchical linear regression was used to determine whether LCn3PUFA intake predicted the variability of ABI,

resting HR and baPWV when covariates (MBP, HR, cholesterol/HDL ratio, age, gender, BMI, whether participants reported taking fish oil supplements, total energy intake and CVD-related comorbidities such as heart disease, hypertension and diabetes mellitus) were controlled. As the accuracy of baPWV may be reduced in the case of lower limb artery stenosis,<sup>48,49</sup> the analysis between LCn3PUFA and baPWV was repeated with participants with ABI <0.9 excluded. Preliminary analysis was conducted to detect violations of normality, linearity, multicollinearity and homoscedasticity, with no violations of assumptions found.

To further explore the relationship between LCn3PUFA intake and HR, participants were categorised as those with an HR below 69 beats per minutes (<69 bpm) and those with an HR of 69 bpm or above (≥69 bpm). These cut-offs were selected based on the findings of a previous meta-analysis which observed greater effects of fish oil on HR in populations with a mean baseline HR of 69 bpm or greater.<sup>50</sup> An independent sample *t*-test was used to compare intake of LCn3PUFA (transformed) between HR groups. The two-tailed *P*-value of <0.05 was taken as statistically significant for all analyses.

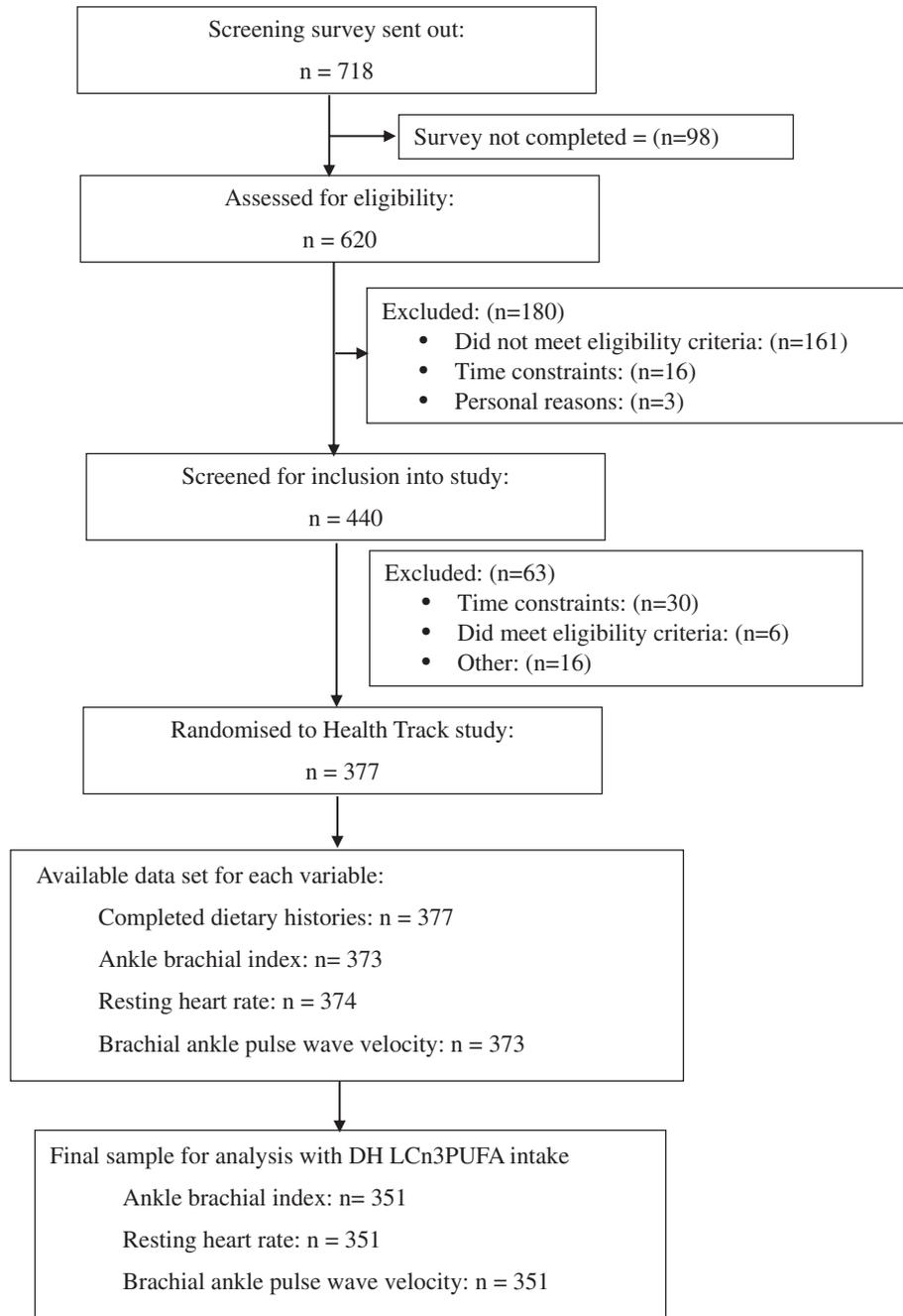
## Results

Table 1 summarises characteristics of study participants at the baseline. The study sample for this analysis was *n* = 351 participants (Figure 1). A total of 24.9% of participants reported consuming LCn3PUFA above the SDT.

**Table 1** Characteristics of the study participants at baseline

Variables	Subsample for analysis			
	<i>n</i>	%	Median	IQR
Age (years)	351		45	37–51
Gender	351			
Male	92	26.3		
Female	259	73.7		
BMI (kg/m <sup>2</sup> )	351		32.1	29.3–35.7
Self-reported medical history of baseline survey	351			
Comorbidities (CVD-related)	104	29.4		
Heart disease	4	1.1		
Diabetes mellitus	21	5.9		
Hypertension	93	26.3		
Fish oil supplements	351			
Taking supplements	20	5.7		
Not taking supplements	331	94.3		
MBP (mmHg)	351		90.67	82–97.33
Cholesterol/HDL ratio	351		3.6	3–4.4
IPAQ (MET min/week)	351		984	466.5–1751
Total energy intake (kJ)	351		9098	7476–11 187
LCn3PUFA consumption (mg)	351		287.6	159.7–518.4
ABI	351		1.06	1.01–1.12
baPWV (cm/s)	351		1180	1084–1313.5
HR (bpm)	351		65	59–72

ABI, ankle brachial index; BMI, body mass index; baPWV, brachial-ankle pulse wave velocity; CVD, cardiovascular disease; HR, heart rate; IPAQ, International Physical Activity Questionnaire; IQR, interquartile range; LCn3PUFA, long-chain omega-3 polyunsaturated fatty acid; MBP, mean blood pressure; MET, metabolic equivalent task.



**Figure 1** Flow diagram for baseline data analysis.

Covariates were entered in Step 1 of the hierarchical linear regression to compare LCn3PUFA intake and ABI, explaining 40.1% of the variability in ABI. In Step 2 after entering LCn3PUFA intake, 42.6% of the variance was explained ( $F(12, 339) = 6.277, P < 0.05$ ). LCn3PUFA intake explained an additional 3.6% of the variance in ABI, after controlling for other variables ( $R^2$  change = 0.021,  $F$  change (1, 339) = 8.864,  $P < 0.05$ ). In the final model, LCn3PUFA intake was statistically significant, with a low beta value ( $\beta = -0.036, P < 0.05$ ) (Table 2).

During analysis of LCn3PUFA intake and baPWV, covariates were entered in Step 1, explaining 73% of the variability in baPWV. In Step 2 after entering LCn3PUFA intake, there was no change of variance ( $F(12, 339) = 32.190, P < 0.05$ ) after controlling for other variables ( $R^2$  change = 0.001,  $F$  change (1, 339) = 0.725,  $P > 0.05$ ). In the final model, LCn3PUFA intake was not statistically significant, with a low beta value ( $\beta = -0.006, P > 0.05$ ) (Table 2). Exclusion of participants with ABI  $< 0.9$  from this analysis did not change the relationship observed ( $\beta = -0.007, P > 0.05$ ).

**Table 2** Regression analysis summary table of ABI, HR and PWV

	ABI (n = 351)			HR (n = 351)			baPWV (n = 351)		
	B	SE B	$\beta$	B	SE B	$\beta$	B	SE B	$\beta$
Step 1									
Constant	1.897*	0.212		1.361*	0.137		1.560*	0.146	
Age 20–30 years	−0.029*	0.016	−0.103	0.029*	0.012	0.139	−0.057*	0.009	−0.268
Age 30–40 years	−0.008	0.011	−0.039	0.006	0.009	0.045	−0.033*	0.007	−0.225
Age 50–60 years	0.010	0.011	0.056	−0.004	0.008	−0.032	0.027*	0.006	0.204
Log energy	−0.004	0.036	−0.006	0.018	0.027	0.036	0.035	0.020	0.070
Log BMI	−0.084	0.082	−0.055	0.258*	0.058	0.233	−0.050	0.048	−0.044
Log cholesterol/HDL ratio	0.026	0.036	0.040				0.028	0.021	0.057
Gender (male)	0.041*	0.011	0.213	−0.006	0.008	−0.040	0.012	0.006	0.080
Comorbidities	0.004	0.010	0.023	0.027*	0.007	0.195	0.013*	0.006	0.092
Log MBP							0.549*	0.053	0.461
Log HR	−0.392*	0.074	−0.286				0.221*	0.042	0.214
Log IPAQ	0.004	0.005	0.040	−0.006	0.004	−0.083	0.003	0.003	0.039
Supplements	0.015	0.017	0.045	0.007	0.012	0.030	0.012	0.009	0.046
Step 2									
Constant	1.974*	0.211		1.392*	0.137		1.573*	0.147	
Age 20–30 years	−0.031*	0.015	−0.111	0.026*	0.012	0.125	−0.058*	0.009	−0.272
Age 30–40 years	−0.010	0.011	−0.052	0.001	0.008	0.005	−0.034*	0.007	−0.231
Age 50–60 years	0.013	0.011	0.069	−0.003	0.009	−0.024	0.028*	0.006	0.207
Log energy	0.005	0.036	0.008	0.022	0.027	0.045	0.037	0.020	0.073
Log BMI	−0.069	0.081	−0.045	0.259*	0.058	0.234	−0.048	0.048	−0.042
Log cholesterol/HDL ratio	0.011	0.036	−0.017				0.026	0.021	0.053
Gender (male)	0.044*	0.011	0.229	−0.004	0.008	−0.031	0.012	0.006	0.083
Comorbidities	0.002	0.010	0.013	0.025*	0.007	0.184	0.013*	0.006	0.090
Log MBP							0.548*	0.053	0.461
Log HR	−0.415	0.073	−0.303				0.217*	0.042	0.211
Log IPAQ	0.003	0.005	0.031	−0.005	0.004	−0.073	0.003	0.003	0.042
Supplements	0.017	0.017	0.051	0.008	0.012	0.034	0.012	0.009	0.047
Log LCn3PUFA	−0.036*	0.012	−0.152	−0.021*	0.009	−0.120	−0.006	0.007	−0.033

ABI, ankle brachial index; baPWV, brachial-ankle pulse wave velocity; BMI, body mass index; HR, heart rate; IPAQ, International Physical Activity Questionnaire; LCn3PUFA, long-chain omega-3 polyunsaturated fatty acid; Log, logarithmic; MBP, mean blood pressure.

\*  $P < 0.05$  (significantly associated).

While analysing variability of LCn3PUFA intake and HR, all covariates were entered in Step 1, explaining 35.1% of the variability in HR. After entering LCn3PUFA intake in Step 2 explained variance was 37% ( $F(9, 342) = 5.341, P < 0.05$ ). Adding LCn3PUFA intake explained an extra 2.1% variance in HR, after controlling for other variables ( $R^2$  change = 0.014,  $F$  change (1, 342) = 5.337,  $P < 0.05$ ). LCn3PUFA intake was statistically significant, with a low beta value ( $\beta = -0.021, P < 0.05$ ) (Table 2).

The independent samples  $t$ -test indicated that participants with an HR of 69 bpm or higher had significantly lower intakes of LCn3PUFA than those with an HR less than 69 bpm ( $t(349) = -2.471, P = 0.014$ , two-tailed test; Table 3). The magnitude of the differences in the means (mean difference =  $-0.1$ , 95% CI:  $-0.18$  to  $-0.02$ ) was very small ( $\eta^2 = 0.017$ ).

## Discussion

In this secondary analysis of baseline data on overweight and obese individuals from a clinical trial, LCn3PUFA

intake was inversely associated with ABI and resting HR. This finding confirms that the favourable relationship between LCn3PUFA and resting HR observed in previous research<sup>50,51</sup> can also be observed in the clinical setting. The relationship between ABI and LCn3PUFA observed in the present study should be interpreted with caution. While there is evidence suggesting that lower ABI may indicate higher risk of cardiovascular disease,<sup>2,5</sup> low ABI in the younger participants in the present study may not reflect lower extremity arterial disease. Furthermore, there was no association observed in the present study between reported LCn3PUFA and baPWV.

**Table 3** LCn3PUFA intake between HR categories

Pulse category	Median intake (mg/dL)	IQR (mg/dL)
HR less than 69 bpm	228	138–455.23
HR of 69 bpm or higher	176.90	581.59

HR, heart rate; IQR, interquartile range; LCn3PUFA, long-chain omega-3 polyunsaturated fatty acid.

While the relationship between LCn3PUFA and ABI should be interpreted with caution, there are a number of mechanisms by which LCn3PUFA consumption may be associated with reduced ABI and HR. LCn3PUFA intake may influence ABI by reducing inflammatory cytokine production through incorporation into the cell membrane.<sup>52,53</sup> Furthermore, LCn3PUFA-derived Eicosapentaenoic acid (EPA) has been found to improve endothelial function via nitrous oxide-dependent vascular relaxation and Docosapentaenoic acid (DHA) modifies lipid composition and the structure of the vessel wall by altering adhesion molecules, ultimately improving endothelial and vessel compliance.<sup>53</sup> It is possible that LCn3PUFA consumption may reduce ABI by means of inflammatory reduction and modification of endothelial and vascular function.

Findings of animal studies have suggested LCn3PUFA consumption may alter the automaticity of heart muscle cells similar to Class I antiarrhythmic medications.<sup>54</sup> LCn3PUFAs can alter the resting membrane potential of heart muscle cells, predominantly the SA node, by direct action on the cell membrane. This effect can increase membrane threshold resulting in a delay in the next autogenerated impulse, leading to a reduction of resting HR.<sup>54</sup> Increased consumption of LCn3PUFA via fish oil was associated with a reduction of HR by 2.5 bpm in individuals with a baseline HR of 69 bpm or higher which is associated with reduced cardiac morbidity.<sup>50</sup> This observation may be suggestive of a cardiac protective effect of LCn3PUFA consumption via reducing arrhythmogenicity and improved reserved capacity. However, in the present study, the magnitude of the association between LCn3PUFA intake and HR was very small. The median intake, even in the group with a resting HR <69 bpm, was still below the preferable 250 mg/day (EPA + DHA) supported by longitudinal evidence for cardiac benefits.<sup>55</sup> In our study population, there were other significantly associated risk factors contributing to resting HR such as age and BMI (Table 2), however, these results suggest that LCn3PUFA intake are a potential target for dietary modification within clinical practice.

Given the association between overweight and obesity and PWV,<sup>56</sup> it is relevant to explore dietary components associated with improved PWV in this at-risk population, in order to identify potential dietetic strategies for reducing cardiovascular risk. In contrast to the findings for ABI and HR, we did not observe an association between LCn3PUFA consumption and baPWV in this setting. This finding does not align with those of previous studies using LCn3PUFA supplements with therapeutic doses.<sup>57,58</sup> The disparity in findings may be explained by variations in the study population, the amount of LCn3PUFA intake and dietary assessment methods used. For example, age is a well known major determinant of vascular stiffness, which increases significantly after the age of 55.<sup>59,60</sup> The median age in the present study group was 45 years. Our population may be too young to demonstrate a significant association between vascular stiffness (baPWV) and higher LCn3PUFA consumption. Furthermore, baPWV was used to measure vascular stiffness in the current study. However, carotid-

femoral Pulse Wave Velocity (cfPWV) is the gold standard measurement of aortic stiffness and is considered to be a prognostic indicator of CVD risk,<sup>7,10,61,62</sup> with baPWV validated as a cardiovascular risk factor in Asian communities only. This may be another reason for the disparity in results between studies as they used inconsistent PWV measuring methods. While some research suggest cfPWV and baPWV may similarly predict CVD risk,<sup>63</sup> baPWV results should be generalised to European communities with caution.

Previous studies and reviews have demonstrated therapeutic effects on the endothelial and vascular system in different doses of LCn3PUFA supplements, between 0.45 and 3 g/day.<sup>60,64–67</sup> However, the cardiac effects of LCn3PUFA are evident at lower doses such as 1 g/day or less.<sup>33,55,66,68</sup> In the current analysis, resting HR was significantly associated with LCn3PUFA at an even lower consumption level. Importantly, this relationship was observed at intake levels associated with moderate consumption of dietary sources of LCn3PUFA. In contrast, however, in the current study, LCn3PUFA intake may not have been sufficient to be associated with a lower baPWV. Research findings provide insight into potential dietetic strategies for improving cardiovascular risk. These findings further appear to be reflective of the inconclusive nature of the body of evidence surrounding the impact of LCn3PUFA on cardiovascular outcomes more broadly, as highlighted by a recent systematic review and meta-analysis on the impact of LCn3PUFA supplements on coronary heart disease.<sup>69</sup> Though there are beneficial cardiovascular effects observed in therapeutic doses of LCn3PUFA, further research is needed exploring the impact of LCn3PUFA from dietary sources on cardiovascular measures specifically vascular indicators such as baPWV and ABI.

The present study had some limitations which may have affected the results. The present study was a baseline secondary analysis of data from the HealthTrack study, which was not designed to assess LCn3PUFA intake and cardiovascular outcomes. As such the HealthTrack study was not powered to address this specific question, which may have affected our results. As the present study utilised baseline data, it was a cross-sectional analysis and therefore cannot draw conclusions regarding causation. The DH used was not standardised for LCn3PUFA intake assessment and there was no objective measure of LCn3PUFA intake available such as erythrocyte LCn3PUFA levels. Estimation of LCn3PUFA intake may have also been limited by the availability of food products within AUSNUT 2007. Furthermore, the present study was not able to quantify the LCn3PUFA supplement intake by the study population, which has been suggested to play a major role in Australians achieving the SDT for LCn3PUFA.<sup>42</sup> However, whether participants reported taking LCn3PUFA or fish oil supplements was included as a covariate during the analysis to alleviate this limitation. The HealthTrack study used AUSNUT 2007, the most recent food composition database available at the beginning of the study; however AUSNUT 2007 only reports total LCn3PUFA rather than EPA and DHA separately. This may limit comparisons with LCn3PUFA studies in the literature.<sup>70–73</sup> Measurement of

baPWV and ABI did not follow standard operational procedures published by the American Heart Association for vascular research,<sup>60</sup> and the device used to measure baPWV and ABI was only standardised for the Japanese population.<sup>60</sup> However, the HealthTrack study was designed to be aligned with clinical practice, and thus may correspond with methods used in the clinical setting. Finally, the HealthTrack study involved overweight and obese self-selected volunteers from regional New South Wales, therefore, results may not be generalisable to the broader population.

This secondary analysis of baseline data from a weight loss trial confirms that the favourable relationship between LCn3PUFA intake and CVD risk factor HR can also be observed in the clinical setting. In contrast, relationships with ABI and pulse wave velocity require further investigation. These results add to the current evidence surrounding the potential benefits of LCn3PUFA consumption and highlight the importance of targeting food sources of this nutrient in clinical dietetic practice.

Given the findings of this cross-sectional analysis, it will be beneficial to explore these results further in randomised controlled trials to assess the effect of changes in dietary LCn3PUFA intake on novel cardiovascular risk indicators.

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## Conflict of interest

The authors declare they have no conflict of interest.

## Authorship

AS was involved with the formulation of research questions, study design, data cleaning, analysis and writing of the manuscript. EN was involved with the formulation of research questions, study design, data cleaning and reviewing data analysis and manuscript. GP and LT were involved with the formulation of research questions, study design and reviewing data analysis and manuscript.

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## ORIGINAL RESEARCH

## Classification of diagnostic subcategories for obesity and diabetes based on eating patterns

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Obesity and type 2 diabetes are complex conditions associated with multiple risk factors,<sup>1,2</sup> of which, unhealthy eating habits have been hypothesised to be a particularly important driver.<sup>3</sup> Although an unhealthy diet is undoubtedly an important factor in both obesity<sup>3</sup> and type 2 diabetes,<sup>4</sup> in Mexico, which is among those countries bearing the highest prevalence of these conditions in adults,<sup>1</sup> to date there is scant evidence as to whether obese Mexican adult eating behaviours differ from those of the non-obese or diabetics. The question then is: to what extent do the diets of those with obesity and/or diabetes differ (if at all), from those without obesity and/or diabetes, given a previous medical diagnosis of the condition? Are they predictive of said health states?

We examined these questions by constructing predictive models relating dietary habits to health conditions using standard data mining techniques. To date, despite the wealth of medical and health-related data, data mining techniques have not yet been widely used in this area.<sup>5,6</sup> Certain advances are though being made, for example, in heart disease<sup>7</sup> and lung cancer<sup>8</sup> prediction, as well as in post-stroke mortality.<sup>9,10</sup> Examples of data mining techniques applied to nutrition and eating patterns are very limited, however, suggestions have been made for their use.<sup>11, 12</sup>

The research question this paper aimed to address was: Can eating patterns be used to predict and correctly classify adults from a Mexican population as having obesity, diabetes or both, when measured for eating frequency, number of portions and types of food eaten? To answer the question, we used a naïve Bayes classifier to build predictive models based on eating behaviour,<sup>13</sup> as proxied by self-reported consumption, where the classes representing health condition were: non-diagnosed (no previous diagnosis of obesity or diabetes), obese (previous diagnosis of obesity but not of diabetes), diabetic (previous diagnosis of diabetes but not obesity) and obese diabetic (previous diagnosis of both obesity and diabetes). Predictive models were created for diabetic, obese and obese diabetic classes, and classifier performance is analysed.

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**Table 1** The breakdown of the ENSANUT 2006 data by diagnostic subcategory for anthropometric variables

Diagnosis	Non-diagnosed	Obese	Diabetic	Obese diabetic
Total, n (%)	15 544 (84.5)	1150 (6.3)	1393 (7.6)	298 (1.6)
Women, n (%)	9518 (61.2)	849 (73.8)	872 (62.6)	186 (62.4)
Age, mean (SD)	39.02 (12.3)	39.81 (11.1)	52.34 (10.8)	50.31 (10.7)
Height, mean (SD)	1.57 (0.1)	1.57 (0.1)	1.56 (0.1)	1.57 (0.1)
Weight, mean (SD)	67.86 (13.8)	81.62 (16.4)	69.79 (14.1)	82.37 (16.5)
Body mass index, mean (SD)	27.60 (4.9)	32.96 (5.6)	28.74 (5.0)	33.28 (5.7)

## Methods

The data used for this study was taken from the Mexican National Health and Nutrition Survey 2006 (ENSANUT 2006).<sup>14,15</sup> It is freely available online via registration, and the corresponding ethics committee approved of its design and execution. The nutritional data used here is taken from a self-reported food frequency questionnaire, obtained through face-to-face interviews.<sup>14,15</sup> While this may not accurately reflect consumption, and be subject to biases, evidence exists showing that these methods may give an unbiased representation of diet and intake for a population in various circumstances.<sup>16–18</sup> Of 20 360 adults in the dataset with available nutritional data, adults within the age range 20–69 were included in the study. Exclusions were made based on any incomplete or missing data entries in variables necessary for the purpose of the analysis. Women with gestational diabetes were also excluded. The final dataset contained 18 385 adults.

The question posed in the ENSANUT 2006 questionnaire regarding diagnosis of obesity was ‘Have you ever been told by a doctor/dietician/nutritionist that you have or had obesity?’ Similarly, for diabetes ‘Has a medical professional told you that you have diabetes or high blood sugar?’ Based on the self-reported answers to these questions, data were categorised into four subgroups: non-diagnosed, obese, diabetic and obese diabetic. Diagnoses of other conditions were ignored. A breakdown of the data can be seen in Table 1 for anthropometric variables.

The techniques in this work are based on statistical data mining used to analyse consumption of food groups and create profiling, classifier-based models. First, all foods were divided into distinct nutrition groups. Following discussions with a nutritionist, the following seven main food groups were used: (i) cereals and grains, (ii) vegetables, (iii) fresh fruits, (iv) dairy, (v) meat, fish and eggs, (vi) sugars and fats and (vii) fast food.

The ‘portions per day’ variable was calculated by multiplying the number of days a week a food item was consumed by the number of portions per sitting, then dividing by 7 to obtain the average number of portions consumed per day for each individual food. A comparison of means via a *t*-test was used to statistically analyse the differences between health statuses.

As we were considering the problem from a classification perspective, we used a binomial test<sup>13, 19</sup> as a statistical diagnostic, with each of the seven food groups being analysed for their significance relative to the null hypothesis that the number of portions of a given food group does not affect the

diagnostic subcategory of the individual. Our diagnostic,  $\epsilon$ , can be seen in Equation (1):

$$\epsilon = \frac{N_X(P(C_A|X) - P(C_A))}{\sqrt{N_X P(C_A)(1 - P(C_A))}}, \quad (1)$$

where  $P(C_A)$  is the total proportion of the people in the diagnostic subcategory ‘A’ (non-diagnosed, obese, diabetic or obese diabetic). The probability  $P(C_A|X)$  represents the proportion of people in the diagnostic subcategory conditioned on the variable  $X$ .  $N_X$  is the number of people associated with the variable  $X$ . In the case where the binomial distribution can be approximated by a normal distribution,  $|\epsilon| > 1.96$  would represent the 95% CI. When the sample sizes and/or probabilities  $P(C_A)$  are not compatible with the normal approximation, a more sophisticated approach may be taken using Wilson intervals.<sup>20</sup>

We wish to classify health states according to self-reported nutrition and so are interested in  $P(C|X)$ , the probability to be in a specific health state  $C$ , given the vector of nutritional inputs  $X = (X_1, X_2, \dots, X_n)$ . To proceed, we use Bayes theorem:

$$P(C|X) = \frac{P(X|C)P(C)}{P(X)}. \quad (2)$$

To avoid calculating the normalisation factor  $P(X)$ , a score function is calculated as:

$$S(C|X) = \ln \left( \frac{P(C|X)}{P(\bar{C}|X)} \right) = \ln \left( \frac{P(X|C)}{P(X|\bar{C})} \right) + \ln \left( \frac{P(C)}{P(\bar{C})} \right),$$

where  $\bar{C}$  is the complement of the class  $C$ , or some other reference class. This is simplified to the naïve Bayes classifier by assuming independence between variables, such that the likelihood  $P(X|C) = \prod_{i=1}^N P(X_i|C)$ , to find:

$$S(C|X) = \sum_{i=1}^N s(X_i) + \ln \frac{P(C)}{P(\bar{C})}, \quad (3)$$

where  $s(X_i) = \ln \frac{P(X_i|C)}{P(X_i|\bar{C})}$  is the contribution to the overall propensity to belong to the class  $C$  from the variable  $X_i$ . If  $s$

( $X_i$ ) > 0, the factor contributes positively to class membership; while  $s(X_i) < 0$  contributes negatively.

The naive Bayes classifier is a computationally efficient, simple, robust and transparent classification algorithm;<sup>13,19</sup> even if the assumption of independence is not met, it still performs well.<sup>21,22</sup> While it is true that different techniques may provide varying results, as discussed in Batterham *et al.*,<sup>12</sup> the naive Bayes classifier has been proven to provide good, accurate results across a range of studies.<sup>13,19 21–24</sup> For all these reasons, it is a good choice of prediction algorithm, certainly as a starting point, in many applications of data mining.

For the classification analysis, portion number for each type of food was discretised into seven groups—Group 1 represents  $0 \leq \text{Portions} < 1$ ; Group 2 represents  $1 \leq \text{Portions} < 2$  and so on until Group 7 for six or more portions. Models were built using a random 70%/30% training/test split of the original data. Five-fold bootstrapping, a data resampling method,<sup>25</sup> was carried out to reduce sampling error.

The class score for each individual in the test set is ordered from highest to lowest and divided into 10 equally sized deciles. Decile 1 contains the 10% of the data with the highest total score and Decile 10 contains the 10% with the lowest total score. Sensitivity, defined as,  $TP \times 100/T_d$ , the percentage of individuals with the condition within each decile, where TP is the number of true positives in the decile and  $T_d$  is the total number in the decile, was calculated for each decile and its variation across the deciles used as a measure of performance. A random model would lead to an equal percentage of true positives in each decile. Coverage was also calculated for each decile, accounting for the percentage of the total number of people in the diagnostic subcategory found in a given decile.

## Results

To gain a general understanding of eating behaviour, it was important to look at the average portions consumed per day for the four diagnostic subcategories, as seen in Table 2. Here, the non-diagnosed were used as a reference category.

Adults diagnosed with obesity reported higher average consumption of every food group ( $P < 0.001$ ), except fast food, relative to the non-diagnosed group. The obese-diabetic group also reported higher consumption than the non-diagnosed

across all food groups ( $P < 0.001$ ) other than fast food and meat and fish. The diabetic subgroup consumed significantly less meat and fish, sugars and fats and fast food (all  $P < 0.001$ ) than the non-diagnosed group. However, in the other food groups there were no significant differences. Particularly notable was the difference in sugars and fats compared to adults with obesity ( $t = 16.817$ ,  $P < 0.001$ ). There was also strong evidence that those with obesity also consumed more portions of vegetables and fresh fruits ( $t = 9.259$  and  $5.126$ , both  $P < 0.001$ ) than the non-diagnosed. This was also true for those with both obesity and diabetes ( $t = 5.507$ ,  $P < 0.001$  and  $t = 3.072$ ,  $P = 0.002$ , respectively).

For each individual food group, the score was calculated using the number of portions in the different food categories as the variables,  $X$ , and the diagnostic subcategory (obesity or diabetes or both) as the class,  $C$ . For each person in the dataset, a total score was calculated by summing the scores for the portions of each food group. The results of score decile testing for percentage sensitivity, for all three variations of the model, can be seen in Figure 1.

The model for those with diabetes provided the best performance results of the three conditions, where sensitivity for Decile 1 was 19.9%. In the test portion of the data there was an average of 563 diabetics which related to an average random performance for diabetics of 8.3%. Thus, a score for this model in Decile 1 is approximately 2.4 times better at determining diabetics than random chance, while a score in Decile 10 corresponds to sensitivity of 3.8%, less than half the random benchmark, indicating that the model discriminates well between diabetics and non-diagnosed.

The model for obesity is slightly less conclusive, with a sensitivity of 9.3% and 8.9% in Deciles 1 and 2, respectively compared to the 5.9% average random performance of model for adults with obesity. Thus, for the obese model, a score which falls in the top two deciles almost doubles the chance of correctly identifying obesity, while the sensitivity in Decile 10 at 3% is about half of the 5.9% baseline. Once again, the pattern decreases monotonically through the deciles.

There was an average of only 115 people diagnosed with both obesity and diabetes in the test set of 6786 across the five bootstrapped models, which gave the random performance benchmark of 1.7%. Despite this, a Decile 1 score

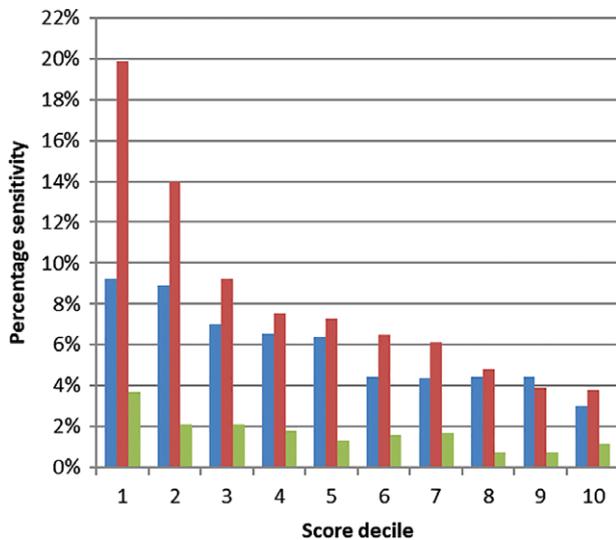
**Table 2** An average portion analysis for each of the seven food groups

	Portions (mean (SD))			
	Non-diagnosed	Obese	Diabetic	Obese diabetic
Cereals and grains	1.42 (1.03)	1.54** (1.16)	1.43 (1.02)	1.57* (1.10)
Vegetables	1.79 (2.11)	2.40** (2.58)	2.11** (2.36)	2.48** (2.60)
Fresh fruits	1.38 (1.48)	1.61** (1.68)	1.41 (1.47)	1.65* (1.60)
Dairy	0.92 (0.91)	1.15** (0.97)	0.95 (0.82)	1.12** (0.88)
Meat and fish	1.64 (1.31)	1.88** (1.42)	1.42** (1.15)	1.76 (1.25)
Sugars and fats	3.00 (2.12)	3.27** (2.17)	1.98** (1.71)	2.35** (1.83)
Fast food	0.66 (0.95)	0.66 (0.91)	0.53** (0.79)	0.63 (0.92)

Each diagnostic subcategory is compared against the reference category, non-diagnosed.

\* $P < 0.05$ .

\*\* $P < 0.001$ .



**Figure 1** Average sensitivity performance analysis for the score models for classification of obese, diabetic and obese diabetic subcategories based on number of portions consumed. (■) Obese; (■) diabetic; (■) obese diabetic.

(where performance was 3.7%) provided a 2.18 times higher probability than random chance at determining a person with both obesity and diabetes.

Using the score decile method of testing, analysing the coverage of the model was also possible. The coverage analysis for all models is shown in Figure 2.

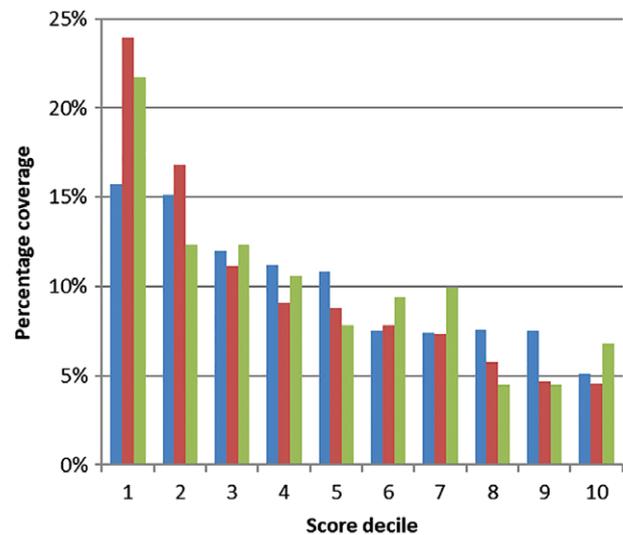
The coverage analysis results indicate that the diabetic subgroup gives the strongest results, closely followed by the obese diabetic model. Nearly a quarter of all diabetics are contained in the first score decile, with 40.8% contained in the first two deciles. The diabetic subgroup also produces the most consistent decreasing pattern from Decile 1 to Decile 10.

Obese diabetics have the second strongest pattern in terms of coverage, where the first two score deciles account for 34.1% of all obese diabetics. They also show a decreasing pattern, but this is lost as Deciles 6 and 7 show an increase on the previous deciles, as is the case with Decile 10.

The model for obesity is the weakest of the three coverage-wise in the highest deciles, with 15.7% and 15.1% in Deciles 1 and 2, respectively. Nevertheless, the model for obesity does exhibit a steady decreasing pattern from Decile 1 to Decile 10 without any increases, unlike the model for both conditions together.

## Discussion

The results of the models and the subsequent score decile testing as a measure of performance show that health state can be predicted from self-reported dietary patterns, or alternatively, that a given health state is predictive of a given dietary pattern. Although we used a naïve Bayes classifier, with its associated advantages of efficiency, simplicity, robustness and transparency,<sup>13,19</sup> the present study can be used as a starting point for the application of more



**Figure 2** Average coverage analysis for the score models for classification of obese, diabetic and obese diabetic subcategories based on number of portions consumed. (■) Obese; (■) diabetic; (■) obese diabetic.

sophisticated data mining techniques in the area of nutrition<sup>26</sup> where some success has been seen related to type 2 diabetes.<sup>27</sup> Note that the performance of each model is roughly similar, leading to sensitivities in the top/bottom decile about 2/0.5 times the random baselines of 8.3%, 5.9% and 1.7% for diabetics, obese and obese diabetics, respectively.

Comparing the results of the performance sensitivity analysis and the coverage analysis, the model for people with diabetes provided the strongest results and highest classification level. This indicates that the eating patterns of the diabetic subgroup are the most rigid, with successful classification driven by the low reported consumption of sugars and fats. The models for obesity and for those with both obesity and diabetes also show promising results which, with the benefit of more data, can lead to good prediction and classification using these techniques.

There are at least two alternative interpretations of our results. One is that it just reflects relative reporting biases between one group and another. The second is that it reflects genuine changes in eating habits as a consequence of a diagnosis by a medical professional of obesity or diabetes. For the former there is the question of what expectation one should have about any reporting bias associated with a given group. We see that here the diagnosed obese report much higher consumption than the non-diagnosed. This may be a reaction to the diagnosis by a medical professional itself; that the diagnosed obese are more aware of their true dietary habits. It may also be the case that people with diabetes underreport sugar consumption and people with both obesity and diabetes overreport vegetable consumption.

An alternative hypothesis, that we prefer, is that the self-reported dietary patterns reflect real changes because of the

presence of a changed health state and action being taken on the advice of a medical professional. In the case of diabetics, this means much less consumption of sugars and fats and fast food and enhanced consumption of vegetables. In the case of obese diabetics we notice that their pattern of consumption is intermediate between that of people with obesity and those with diabetes. In particular, their sugar consumption is low relative to individuals with obesity but greater than that of those diagnosed diabetic. Indeed, their consumption of all other food groups is higher than that of people with diabetes and comparable to people with obesity.

What seems clear is that a diagnosis of diabetes is associated with a change in the self-reported dietary pattern that is both notable and consistent with the required response to the diagnosis. On the other hand, a diagnosis of obesity does not correlate with any significant expected reduction in consumption relative to the non-diagnosed group.

In summary, we hypothesise that the adult Mexican population in general is responsive rather than preventive in terms of obesity and diabetes. Clear, positive action in terms of diet is on average only taken by the diabetic subgroup. We also see that those with obesity have higher average consumption across all food groups, suggesting that they have not reduced their dietary intake sufficiently in spite of a medical diagnosis of their condition. Although there is an increase in consumption of vegetables and fruit, the baseline factor remains: they simply consume more of all food groups, rather than follow a stricter diet. Thus, although obesity is an important risk factor for chronic disease, including diabetes, the results we have shown indicate that as a medical condition it is not taken seriously enough so as to lead to a relevant change in dietary pattern.

We believe that focus needs to be placed on the prevention of obesity rather than a reaction upon its arrival. Not only to stop the onset of further health complications but because typically, it is extremely difficult for the body mass index obese to return to a normal weight, as emphasised, for example, by Fildes *et al.*<sup>28</sup>

We recognise several potential limitations of this research: (i) as all nutritional variables and diagnosis of obesity and diabetes are self-reported they are subject to recall and other biases; (ii) the data is cross-sectional making causal inference more difficult and (iii) the male/female ratio for the ENSANUT respondents is skewed and thus not fully representative of the Mexican population.

In conclusion, as the growth in availability of medical and health-related data is not being matched at the same rate by the growth in usage of data mining techniques,<sup>29</sup> we have provided a strong example of the benefit of such techniques by applying a naïve Bayes classifier to nutritional data in order to classify adults based on their health status. The successful construction of such models we hope will encourage and promote further use of similar data mining techniques in nutrition and related areas. Although the limitations of the data considered do not allow us to arrive at a unique interpretation of the results, the predictive value of the models we have developed is quite independent of any

subsequent interpretation. However, we would argue that the results are evidence of the fact that a diagnosis of diabetes is sufficiently impactful that it leads to a significant and positive change in dietary pattern, whereas this is not the case for a diagnosis of obesity.

It is imperative that the seriousness of weight gain and obesity is stressed to the Mexican population, along with the importance of diet related to these conditions.

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## Conflict of interest

The authors declare that they have no conflict of interest.

## Authorship

JFE and CRS designed the study, JFE and HRS carried out the mathematical and statistical analysis, JFE and CRS wrote the manuscript. All authors reviewed, revised and approved the final manuscript. The authors would like to thank Dr Guillermo Meléndez for his opinion regarding our results. The authors also thank Juan Arturo Herrera-Ortiz for his assistance in determining the food groups defined here.

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## ORIGINAL RESEARCH

# Sleeping Well Trial: Increasing the effectiveness of treatment with continuous positive airway pressure using a weight management program in overweight adults with obstructive sleep apnoea—A stepped wedge randomised trial protocol

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### Abstract

**Background:** The majority of adults diagnosed with obstructive sleep apnoea (OSA) are overweight or obese. Continuous positive airway pressure (CPAP) is the most common effective therapy for OSA. However, adherence declines over time with only 50% of patients prescribed CPAP continuing to use it long term. Furthermore, a recent prospective analysis indicated that those more adherent with CPAP therapy have enhanced weight gain trajectories which in turn may negatively impact their OSA.

**Aim:** The Sleeping Well Trial aims to establish whether the timing of starting a lifestyle weight loss intervention impacts on weight trajectory in those with moderate–severe OSA treated at home with CPAP, while testing the potential for smart phone technology to improve adherence with lifestyle interventions.

**Methods:** A stepped wedge design with randomisation of individuals from 1 to 6 months post-enrolment, with 5 months of additional prospective follow up after completion of the stepped wedge. This design will investigate the effect of the 6-month lifestyle intervention on people undergoing CPAP on body weight, body composition and health-related quality of life.

**Discussion:** This trial tests whether the timing of supporting the patient through a weight loss intervention is important in obtaining the maximum benefit of a lifestyle change and CPAP usage, and identify how best to support patients through this critical period.

**Trial Registration:** The protocol (v1) is registered prospectively with the International Clinical Trials Registry (CTR) ACTRN12616000203459 (public access). Any amendments to protocol will be documented via the CTR. Recruitment commenced in March 2016 with data collection scheduled to finish by May 2018.

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**Key words:** modified fasting, obesity, obstructive sleep apnoea, weight management.

### Introduction

Obesity and sleep disordered breathing are highly correlated.<sup>1</sup> The increased prevalence of obesity and, subsequently, obstructive sleep apnoea (OSA) has led to increased demand for treatment of this sleep disorder. Currently, moderate–severe OSA is estimated to affect 10% of men and 3% of women aged 30–49 years which increases to 17% of men and 9% of women aged 50–70 years.<sup>2</sup> Although not all with OSA are overweight, significant proportion are (70%) and severe OSA is an independent risk factor for cardiovascular disease, insulin resistance, type

2 diabetes and stroke.<sup>1</sup> Many patients who lose weight experience an improvement in their OSA.<sup>3</sup> However, the situation is not simple and the relationship is not unidirectional. A systematic review to explore the relationships between OSA and body weight concluded that there was strong evidence that obesity contributes to the pathogenesis of OSA.<sup>4</sup> However, the review also reported that the presence of OSA can reinforce the obese state via alterations to energy metabolism, appetite and satiety (via neural control feedback mechanisms), thereby making it harder for those with OSA to manage their weight and maintain weight loss.

Continuous positive airway pressure (CPAP) is accepted as 'best practice' treatment for moderate–severe OSA. In a report prepared for the Australasian Sleep Association,<sup>5</sup> CPAP treatment was found to be both clinically and cost effective, with an incremental cost effectiveness ratio of \$5K per quality adjusted life year. However, the report also highlighted that patient adherence with CPAP therapy is suboptimal with less than 50% using this therapy long term. Adherence with treatment appears to decline quickly despite reduction in daytime sleepiness.<sup>6</sup> Ongoing support and the patient's initial experiences with CPAP have been shown to be predictors of success.<sup>7</sup>

Importantly, CPAP may have a negative impact on a subject's weight. A meta-analysis involving 25 randomised trials on patients with OSA found that commencing CPAP treatment resulted in a significant increase in weight and body mass index (BMI).<sup>8</sup> Despite this, patients on CPAP do have the ability to lose weight, further leading to an improvement in cardiovascular risk profile. Chirinos *et al.*<sup>9</sup> reported that weight loss plus CPAP was more effective than CPAP alone at improving insulin sensitivity, blood pressure and serum triglycerides. In this study, there was an impressive 11 kg difference in weight between groups, with those randomised to receiving support to lose weight achieving sufficient weight loss to be clinically important in reducing their cardiovascular risk (5–10% body weight).

A comprehensive review of the literature concluded that weight loss via diet and/or exercise interventions are effective in the treatment of OSA.<sup>3</sup> In the included meta-analysis, a mean weight loss of 13.76 kg (95% CI 8.32, 19.21) and a mean reduction in Apnoea Hypopnea Index (AHI) of 16.09 (95% CI 6.54, 25.64) was observed. What was also apparent from this meta-analysis and from other studies<sup>10</sup> is that loss of body weight is important in enabling remission of sleep symptoms (daytime sleepiness, morning headaches) independent of any improvement in OSA severity and that diet approaches are the most effective. Most of these studies had follow-up periods extending out to 1 or 2 years. To date, only one study has had a long term (60 month) follow up.<sup>7</sup> This study was observational and designed to determine if weight loss from a 1-year randomised controlled trial could be maintained and prevent progression of OSA over the long term. The authors reported an 80% improvement in the progression of OSA in those who maintained weight loss. However, a key limitation of this work is that it only recruited those with mild OSA so it remains contentious if lifestyle interventions can objectively

cure those with moderate or severe OSA.<sup>7</sup> Recently, fasting regimes which reduce energy intake on specific days per week and without restriction on remaining days have gained popularity, are simple to follow and have proven just as effective for weight reduction, at least in the short term, than a consistent reduction in daily energy intake.<sup>11</sup> Previously, we have reported success in younger adults, with a modified 5:2 fasting regimen which incorporates a 2-day 'fasting' per week and 5 days of healthy eating, which will be used in this study.<sup>12</sup> Changes in diet (energy in) and activity (energy out) are the cornerstones of any lifestyle intervention<sup>13</sup> but require sustained behaviour changes to counteract the physiological compensatory processes which favour weight re-gain.<sup>14</sup> Those newly diagnosed with OSA have to contend with the use of a CPAP machine, which requires shifts in behaviour both for the patient and potentially any bed-partner. Behaviour change theory clearly indicates that asking people to undertake multiple simultaneous changes is fraught with difficulty.<sup>15</sup> We have highlighted the importance of actively addressing obesity alongside CPAP, but simultaneously commencing CPAP and making multiple complex changes to their diet and exercise regime concurrently (i.e. lose weight plus start CPAP) increases the risk of failure.<sup>16</sup> Adherence to CPAP itself declines up to 83% over the first 3 months of treatment in some studies, indicating that more support is required on initiation to establish this new behaviour, particularly before moving forward with additional lifestyle changes.<sup>17</sup> Therefore, current practice may present potential barriers for patients; multiple concurrent lifestyle changes are expected (CPAP initiation plus weight loss) but with little support. Strategies that separate the initiation of these two therapeutic interventions, such as in using step-wedged intervention designs, where commencement of the intervention of interest are staggered,<sup>18</sup> enable each participant to be exposed to the interventions and does not require an untreated control group.

Providing long-term support to patients is challenging in a health service model designed to prioritise acute care. Following initial education, patients may be left to implement changes on their own. Motivation, improving self-efficacy and social support are key adjuncts to successful long-term behaviour change and any intervention that can incorporate behaviour modification in addition to pure 'education' is likely to have a longer term impact.<sup>13</sup>

Accessibility to lifestyle interventions has moved into a new age with the wide spread uptake of smart phone technology. New technology and smart phones in particular can be used to remind and enable self-monitoring of progress, from which participants gain motivation.<sup>19</sup> Sleeping Well Trial uses an application called MyPace (White October, Oxford UK)—designed by psychologists grounded in behaviour change theory and tested in the context of weight loss. This App provides tailored motivational text messages, reminder messages to prompt desired behaviours, a weight tracker to show progress towards agreed goals and additional support to the user as they can message their dietitian in between face-to-face appointments.<sup>20</sup> Research on the

integration of technology into health care suggests that the right application may be positively accepted by both consumers and practitioners.<sup>21</sup> Furthermore, health-care systems in Europe, Australia and the United States are currently actively encouraging and investing in technological innovations to support available routine care.<sup>22</sup> Time spent in face-to-face contact between individual patients and a health-care professional represents a significant use of resources. Any additional contact time needs to have demonstrable benefits and outcomes.

Thus, the aims of the trial are as follows:

*Primary aim 1:* Investigate the effectiveness of a 6-month lifestyle intervention for reducing body weight in overweight subjects with moderate–severe OSA commencing CPAP.

*Primary aim 2:* Determine whether timing of commencement of a lifestyle intervention affects the change in weight and trajectory of weight experienced 12 months following CPAP commencement.

*Secondary aim 1:* Examine whether people who commence CPAP gain body weight.

*Secondary aim 2:* Examine the potential for smart phone technology to improve adherence with interventions, both lifestyle (diet and physical activity, PA) and with self-administered CPAP and extend the reach and impact of face-to-face advice which is the traditional model of care in hospitals.

## Methods

*Trial design and participants:* We employ a stepped wedge design with randomisation of individuals with 5 months of additional follow-up following completion of the stepped wedge (7 months, Figure 1). The stepped wedge design<sup>18</sup> will be used to investigate the effect of the lifestyle intervention on OSA patients receiving CPAP therapy on body weight, body composition and health-related quality of life. We chose not to use sham CPAP as a control as there are

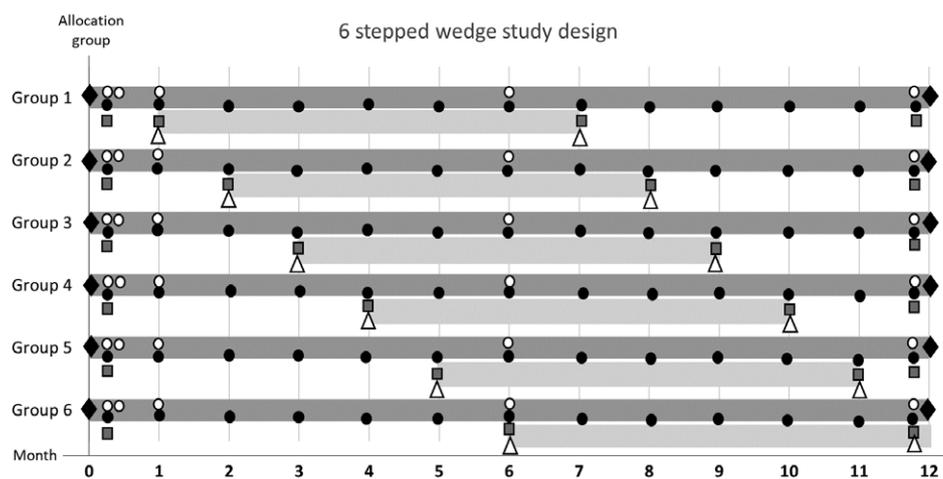
ethical issues in not providing CPAP treatment to this patient group. Crucially, this design enables us to test whether the timing of the intervention delivery impacts on both the absolute change and rate of change in weight by the 12-month post-recruitment assessment.

Ethics approval has been granted from Monash Health and Monash University Human Research Ethics Committee (CF1) HREC/15/MonH/93 Ref 15357A. Dissemination will be via peer-reviewed publications and international presentations. This manuscript was written in accordance with the SPIRIT and CONSORT guidelines.

*Recruitment:* The recruitment phase for this trial commenced in March 2016 and was completed in May 2017. Participants were recruited from two separate Academic sleep centres (Monash Health and Eastern Health) in Melbourne, Australia, which both follow best practice OSA treatment guidelines.<sup>23</sup> Eligible participants were identified and referred by their treating sleep physicians, or self-referred via approved advertising posters displayed in clinic.

*Inclusion criteria:* Patients with moderate–severe OSA (defined by an AHI  $\geq 20$ /hour determined from overnight polysomnography (PSG) according to standard American Academy of Sleep Medicine criteria)<sup>24</sup> and starting CPAP therapy were included. Additional inclusion criteria: patients between 19 and 68 years, self-reported sedentary lifestyle (as per trial registration, engaged in PA less than 2 days per week and a duration of less than 45 minutes per session).

*Exclusion criteria:* Those of Caucasian descent who have a BMI within the healthy range (BMI < 24.9); of Indian and Chinese descent with a BMI < 23; persons with a BMI > 43. Those with an urgent need for CPAP (e.g. commercial or drowsy drivers defined by Epworth Sleepiness Score > 16),<sup>25</sup> those who were unable to provide informed consent in English, were already on a diet/exercise program or diagnosed with concomitant obesity hypoventilation



**Figure 1** Trial design using a six-stepped wedge. (■) CPAP treatment; (□) lifestyle intervention; (△) DXA scan; (●) weigh in; (▲) blood, neck and waist circumference, BP, questionnaires; (○) Air Liquide visit; (◆) overnight sleep study. BP, blood pressure; DXA, dual-energy X-ray absorptiometry.

syndrome were excluded after their PSG study. Additional exclusion criteria: pregnant women, an inability to exercise, receiving VPAP/BPAP, previous treatment for OSA, previous bariatric surgery or persons already on a diet, and those suffering from angina pectoris/atrial fibrillation.

*Procedure:* Patients identified by their treating sleep physician and meeting eligibility criteria provided verbal consent to be further contacted by the trial team by telephone. Self-referring participants were encouraged to phone or email researchers directly (eligibility subsequently confirmed by treating sleep physician). Individuals expressing interest in participating in the trial were then invited to attend a morning screening session after a fast of 10–12 hours the evening prior where inclusion/exclusion criteria were confirmed. Upon written consent, participants were enrolled into the trial, allocated to a treatment group and informed of their wait list period (CB, KD and LG). Group 1 began the lifestyle intervention 1 month after starting CPAP therapy; Group 2 after 2 months, Group 3 after 3 months and so forth, up to a maximum 6 month waiting period. Participants have been asked to continue with their normal lifestyle until their intervention period commences. Once the lifestyle intervention has commenced, it continues for 6 months. This design enables us to randomise each individual participant into groups and then enrol each group to the lifestyle intervention at different time points. Treatment allocation was stored in opaque envelopes and remained unknown until revealed to the researcher on the day each participant was allocated to a group. Randomisation took place using allocation concealment by the trial statistician (TH). Masking participants to group allocation was not possible due to the necessity to participate in the diet intervention. Participants were asked not to reveal their group allocation to their treating CPAP technicians or sleep physician who were blinded to group allocation. Visits for data collection at the university used a staggered by appointment time, thus minimising any likelihood of participants meeting each other. Following randomisation (LG, CB and KD), participants' weight was assessed using a calibrated digital scale (Seca, Hamburg, Germany). Subsequently, their blood pressure, height, waist and neck circumference was measured using standard laboratory operation procedures. A qualified phlebotomist then obtained a 17 mL blood sample from each participant. Blood samples were immediately spun via centrifuge and stored in Eppendorf tubes in a  $-80^{\circ}\text{C}$  biohazard freezer in the research laboratory at Monash University. After blood collection, a light breakfast was provided to participants while they complete a series of validated questionnaires (see *Diet, eating behaviour, sleep, activity and psychosocial measures*). An appointment for the participant to visit the CPAP provider within 1 week of the screening session was organised by the researchers at the end of the session.

Patients underwent mask fitting and education regarding OSA and were provided with a CPAP machine by staff at Air Liquide Healthcare, and access these staff for ongoing support at no cost. Patients are initially commenced on

Autotitrating CPAP using a Resmed S9 CPAP machine. After 1 week of treatment, patients are switched to fixed pressure CPAP based on the 95th centile pressure determined during the autotitration week. Routine equipment troubleshooting is provided by Air Liquide staff at the CPAP centres. The participants' treating sleep physician coordinates all CPAP care and is responsible for any decisions regarding treatment changes. Participants are required to use their CPAP devices regularly for the 12-month period (beginning from consent date). Upon completion, participants will be encouraged to continue standard treatment in collaboration with their treating sleep physician.

*Monitoring:* After enrolling into the trial, all participants are contacted monthly to determine a time for a 10-minute visit at home or at clinic to be weighed. Participants are also asked to provide their CPAP device at the end of the 12-month period so data on usage can be extracted from its built-in memory. These data will provide objective measures of adherence with CPAP therapy and their weight trajectory over time. Any participant who withdraws from the trial will be encouraged to continue standard treatment with their initial referring sleep physician and their weight will be collected from their medical record.

*Lifestyle intervention:* Participants are prescribed a modified fasting diet regime (5:2) with PA recommendations of 3 x 30 minutes per week of light/moderate PA (e.g. increase step count, begin resistance training, low-impact swimming, etc.) for the initial 3 months, followed by a 3-month maintenance phase (Table 1). The dietary regimen consists of 5 days of restricted daily energy intake of 6300–7500 kJ per day and 2 days of very low energy intake between 2200 and 2760 kJ per day. On very low energy intake days, participants are provided with low energy milk shakes, multivitamins with fish oil, fibre and iron (women only) supplements contained in labelled sachets. A single trial dietitian (KR) supports each subject by a face-to-face monthly visit (initial 60 minutes, follow-up 30 minutes) using behaviour change and motivational interviewing techniques augmented in between appointments via communication via the MyPace App. The App enables out-of-clinic communication between the dietitian and the participant, including regular reminders, troubleshooting, motivational messages/encouragement and progress reports. The six face to face consultations with an Accredited Practising Dietitian are designed to enable the participant to set their individual goals in relation to change in diet choices and activity, which develops the individuals' capability to manage their food and activity in the context of their own physical, social and psychological environment. These goals are then programmed into the App which generates automated but predetermined motivational and supportive messages to the participant. Adherence can be assessed via monitoring the closed communication with the dietitian which occurs via the MyPace App. Participant satisfaction with the intervention is requested at the end of the trial and collected via an anonymous semistructured questionnaire. Analysis of these questionnaires enables

**Table 1** The Sleeping Well Trial lifestyle intervention outline

Session	Content covered
1	Review dietary pattern (24-hour recall), take weight measurements, identify key targets for dietary modification based on dietary history, introduce 5:2 modified fast, establish goal weight and physical activity recommendations, set up MyPace and communication strategy
2	Review progress, record weight measurement, monitor adherence to fasting days, review goals from last appointment and discuss barriers/enablers to achieving these
3	Review progress, record weight measurement, monitor adherence to fasting days, review goals from last appointment and discuss barriers/enablers to achieving these, discuss strategy moving into maintenance phase and cessation of fast days take weight measurements
4	Review progress, record weight measurement, review goals from last appointment and discuss barriers/enablers to achieving these
5	Review progress, record weight measurement, review goals from last appointment and discuss barriers/enablers to achieving these, prepare participant to end relationship with dietitian after the next visit, start to think about discharge strategy
6	Review progress, record weight measurement, review goals from last appointment and discuss barriers/enablers to achieve these, provide follow-up options and ensure that a strategy for maintenance/further weight loss is in place

researchers to gain participant insight into aspects of the intervention content, delivery style and structure.

**Outcomes:** The trial is powered on the primary outcome of weight change over time. Weight (kg) is measured using standard techniques at each centre on diagnosis, at the start of CPAP and then monthly at follow-up visits at either the CPAP centres, routine hospital visits or dietitian visits. Digital weighing scales (Seca) are provided at each site or centre to ensure patients are weighed on the same device each month and all staff trained in the standard operating procedure, with routine calibration throughout the duration of the trial. Home visits are available for those who are unable to attend any other options. MyPace application adherence is monitored via in-app message usage. Participants are also asked to rate the MyPace App's usefulness in an end-of-trial feedback form.

**Other outcome measures:** CPAP adherence is measured by regular machine downloads to document hours and days used. In addition, residual AHI on treatment is continually measured via participants' CPAP device, with a final reading taken at 12 months at both the CPAP centre (by CPAP technicians) and main research facility at Monash University

(by the study coordinator). Body composition is measured using the reference technique of GE Lunar iDXA (GE Medical, Software Lunar DPX enCORE 2012 version 14.0, Madison, Wisconsin). Waist and neck circumferences are measured at the same time points as weight verification and blood pressure are monitored.

Blood samples are drawn at screening, baseline, at the end of the lifestyle intervention and at 12 months to measure cholesterol (HDL:LDL), triglycerides, glucose and insulin for monitoring of metabolic cardiovascular risk factors. To gain insight into the molecular mechanism underlying weight change in OSA patients undergoing CPAP, peripheral blood mononuclear cells are isolated from a blood sample at the beginning and end of the weight loss phase to analyse transcriptome modulation in a sub-set (~10) of participants. The transcriptome analysis will involve RNA sequencing, cluster analysis and pathway enrichment to determine overexpressed pathways in this population.

**Diet, eating behaviour, sleep, activity and psychosocial measures:** The following validated questionnaires are completed at screening, baseline, at the end of the lifestyle intervention and at 12 months with data collected from the participant via an iPad and directly uploaded to the trial database: Functional Outcomes of Sleep questionnaire (FOSQ),<sup>26</sup> Epworth Sleepiness Scale (ESS),<sup>25</sup> eating behaviour (TFEQ-R18),<sup>27</sup> Health-Related Quality of Life (EQ-5D),<sup>28</sup> self-reported activity (IPAQ-SF),<sup>29</sup> general health status (SF-36),<sup>30</sup> and history of depression (BDI)<sup>31</sup> and anxiety (HADS).<sup>32</sup>

Diet is measured using a standardised 24-hour recall by the trial dietitian at the beginning of the intervention period and after 6 months. Nutrient analysis of macro- and micro-nutrients will be performed using Foodworks 7 (Xyris Software Pty Ltd., Brisbane, Australia) and performed in duplicate by two independent researchers. Adherence to the dietary plan is monitored by counting unused milkshake and supplement sachets provided over the dietary intervention period and monitoring of the App usage and in-built messaging is used as an indicator of adoption of behaviours and engagement with the support and goal setting provided via the App. Activity is recorded using FitBit 'Flex' devices (FitBit, San Francisco, California) supplied to participants' at time of enrolment, these data being stored on participants' online accounts and accessible by researchers for the duration of the trial. Participants are requested not to change their account password from the one provided at time of set up for the duration of the trial.

**Statistical analysis plan:** Analyses will be undertaken using the 'intention-to-treat' approach, where all evaluable data is analysed in the treatment group according to which the participant was allocated. Statistical significance will be defined as  $\alpha < 0.05$ . All tests conducted will be two-tailed.

We will use multilevel, mixed effects, generalised linear models to investigate primary aims 1 and 2. We will address primary aim 1 from the short- to medium-term perspective using data only from the stepped wedge portion of our design (analysis 1), and from the medium to long-term

perspective using combined data from the stepped wedge portion of our design and the prospective follow up (analysis 2). The dependent variable will be the rate of weight loss or gain relative to their previous assessment ((previous weight subtracted from present weight) divided by period of time between these assessments). Participant number will be treated as a random effect within the model to account for the dependency of observations within each participant. A categorical fixed effect coding for month since trial commencement will be included to account for maturation effects as per guidelines for analysis of stepped wedge trials.<sup>33,34</sup> We will address primary aim 2 using analysis 2, but with the addition of an intervention-by-month of commencement interaction effect. Month of commencement will be entered into the model as a categorical variable. Primary aim 2 will additionally be investigated using an Analysis of Covariance style linear regression analysis approach (analysis 3). Here, only the final baseline assessment of weight treated as a raw score will be used as the dependent variable. Month of commencement of the intervention will be used as a categorical independent variable. The first weight measurement treated as a raw score will be used as a covariate. If this analysis reveals a linear, quadratic or other trend in the effect of month of commencement on the dependent variable, then an additional analysis will be undertaken (analysis 4) where the month of commencement independent variable is entered into the same model as a continuous variable with or without transformations as indicated. Average CPAP treatment adherence since the previous assessment will be used as a covariate in each of these analyses.

Secondary aim 1 will be assessed using only pre-intervention period data from the stepped wedge portion of this trial. These data will test secondary aim 1 using a pre-post intervention design which generates a quasi-experimental standard of evidence as potential maturation biases cannot be accounted for. Here, weight measurements taken at the baseline assessment (prior to CPAP commencement) will be compared to those taken after this following commencement of CPAP. This aim will be examined using a multilevel, mixed effects, generalised linear model (analysis 5). Trial participants will be treated as a random effect and the presence or absence of CPAP will be used as a fixed independent variable. The impact of CPAP will be further examined using a contamination-adjusted intention-to-treat analysis (analysis 6)<sup>35</sup> which will account for participants with poor CPAP adherence potentially contaminating the estimate of the impact of CPAP commencement on body weight. A further analysis will be conducted including a CPAP-by-time since CPAP commencement interaction effect into the same model as analysis 5 (analysis 7). This interaction effect will be examined for a linear, quadratic or other trend in the effect of month of commencement on the dependent variable. If a pattern is identified, an additional analysis will be undertaken (analysis 8) where the month since commencement of CPAP-independent variable is entered into the same model as analysis 5 but as a continuous variable with or without transformations as indicated.

The effect of average CPAP treatment adherence since the previous assessment will be used as a covariate multilevel, mixed effects, generalised linear model. The dependent variable will be the rate of weight loss or gain relative to their previous assessment.

*Sample size calculation:* The stepped wedge component of this design has six separate 'steps'. By recruiting seven participants for each of the six starting time points of the lifestyle intervention, we have 90% power to detect a standardised effect size of 0.40 for the rate of change in body weight outcome for analysis 1. This assumes a conservative Intraclass correlation coefficient of 0.10, two-tailed  $\alpha = 0.05$ , and treats each individual participant as its own cluster (as this is the unit of randomisation). Collecting 10 participants per group to maintain trial power will provide coverage within the trial for a potential drop-out/missing data rate of over 30%.

*Trial management and dissemination:* The trial will continue to be conducted according to research governance principles set out by Monash Human Research Ethics Committee whom maintain the right to audit the trial at any stage. Participant data are collected, entered and stored according to standard confidentiality procedures on a secure server with password-only access and in locked filing cabinets during and following the trial period. All data will be cross-checked by an independent researcher throughout the trial and may only be accessed by the research team. Trial progress will continue to be monitored via monthly collaborative group meetings with the research team whom are ultimately responsible for any decisions regarding the fate of the trial. The trial findings will be presented at conferences and will be reported in peer-reviewed journals by the research team. Any dissemination of the research findings will be by group level data only to protect privacy and confidentiality rights.

## Results

A total of 60 participants have been recruited into the trial (between 22 March 2016 and 11 May 2017). Recruitment was initially predicted to last 6 months, but took longer due to the BMI criteria excluding some potential participants (both higher and lower than inclusion criteria) and being confirmed as having 'mild' rather than 'moderate-severe' OSA after their overnight sleep study. Figure 2 details the recruitment process from both hospital sites. The majority of participants are male (n 44 (73%), with a mean (SD) age of 49.35 years ( $\pm 10.74$ )). The mean (SD) BMI is 34.26 ( $\pm 4.6$ ) with a range of 25.7–43 and with moderate-severe OSA as defined by AHI (mean 46.85 ( $\pm 21.14$ )). Twelve (20%) participants reported being on antidepressants at the time of enrolment and 14 (23%) on medication for hypertension.

## Discussion

As there is growing evidence that CPAP alone may at best support the obese state and at worse lead to increasing weight

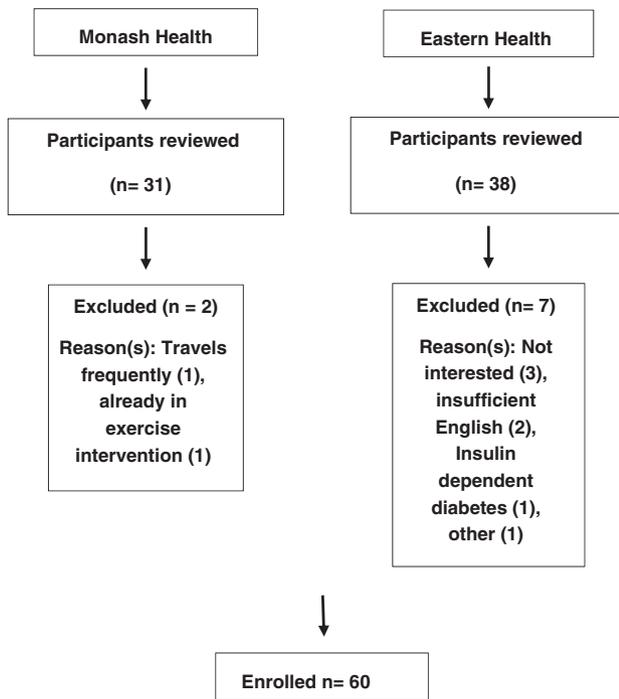


Figure 2 Recruitment flowchart.

in a population vulnerable to weight gain, there is a strong rationale for adding a lifestyle-based weight loss intervention to the treatment of all overweight or obese OSA patients prescribed CPAP at home. It is also important to understand the impact of a lifestyle intervention on metabolic outcomes and psychosocial behaviours. This trial tests whether the timing of supporting the patient through a weight loss intervention is important in obtaining the maximum benefit of a lifestyle change and CPAP usage, and identify how best to support patients through this critical period.

It will extend our knowledge of the aetiology of weight trajectory in patients with moderate to severe OSA who are prescribed CPAP therapy, which is currently lacking. Importantly, the findings will extend our knowledge of treatment pathways that are applicable in practice settings, particularly whether the timing of weight management starts and how that impacts on outcomes. It also examines whether extending the impact and reach of lifestyle interventions with a comprehensive program, including the use of smart phone technology, improves adherence and therefore treatment effectiveness. Thus, the ‘Sleeping Well Trial’ has the potential to encourage a movement towards more personalised interventions to achieve maximal benefit and engagement based on delivery timing and method of communication between dietitian and patient.

## Funding source

This trial is an investigator initiated trial. LG is supported by a Faculty Masters scholarship. Air Liquide are providing CPAP machines and support to participants at no cost and had no role in the trial design and protocol development.

By contractual agreement, researchers at Monash University have responsibility and independence regarding data management, analysis and publication. BAE is supported by a Heart Foundation of Australia Future Leader Fellowship (101167). GH has received equipment to support research from Resmed, Philips Respironics and Air Liquide Healthcare. All other authors declare an absence of funding.

## Conflict of interest

The authors declare no conflict of interest.

## Authorship

HT conceived the trial and the dietary intervention, drafted the manuscript and takes responsibility for the trial fidelity. BAE contributed to the research design and trial conception and contributed to drafting and review of manuscript. DMD provided guidance to the sleep-related aspects of trial design, oversaw recruitment of patients from sleep clinics at Eastern Health, contributed to drafting and review of the manuscript. AY provided input into the sleep-related aspects of trial design at Eastern Health, oversaw recruitment of patients from this site and reviewed the manuscript. LG assisted with recruitment of participants, data collection and management procedures and contributed to drafting and review of manuscript.

CB assisted with recruitment of participants, data collection and management procedures and contributed to drafting and review of manuscript. KR was responsible for delivering the lifestyle intervention, assisted in reviewing and editing of manuscript. MPB contributed to the study design in relation to cardiometabolic markers and review of manuscript. CM provided technical input in blood sample collection and analysis of gene expression. KD provided technical input into the trial and data collection and management procedures, assisted in reviewing and editing the manuscript. TPH contributed to development of the research design, development of the random allocation approach, development of the statistical analysis plan, reviewing and editing of the manuscript, and contribution to the project management committee. GH provided clinical input and guidance to the sleep-related aspects of trial design, oversaw recruitment of patients from sleep clinics at Monash Health, contributed to drafting and review of manuscript. All authors read and approved the final manuscript and declare that this work has not been published elsewhere. The authors would like to acknowledge the staff at AirLiquide centres in Dandenong, Richmond and Eltham for their assistance with the trial.

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## LETTER TO THE EDITOR

### THE SIGNIFICANT INFLUENCE OF 'BIG FOOD' OVER THE DESIGN AND IMPLEMENTATION OF THE HEALTH STAR RATING SYSTEM

To the Editor,

We write to congratulate the Journal on focusing its April 2018 issue on the 'Food Matrix'. As the editorial reminds us foods are more than just the sum of the nutrients they contain and in nutrition practice we need to be cognisant of the distinctions among nutrient-, food- and dietary pattern-health relationships.<sup>1</sup>

Previously we have reported the challenges that can arise in applying a nutrient-profiling (Health Star Rating (HSR)) system to communicate the Australian Dietary Guideline (ADG) recommendations. We reported that 57% of new discretionary foods released into the market between 14/6/2014 and 30/7/17 and participating in the HSR system were displaying  $\geq 2.5$  so-called 'health' stars, even though the ADGs recommend most Australians need to consume less discretionary foods. The very presence of health stars on discretionary foods implies health benefit, displaying half or more of the available stars implies it is an even healthier option. The undue influence of the food industry is likely to be one possible explanation for this finding.<sup>2</sup> Therefore, we were also surprised that the editorial, in citing an article<sup>3</sup> in the issue, stated, 'The HSR development was led by consumer and public health advocacy groups and ensured that its development was not overly influenced by the food industry'.<sup>1</sup> This is not correct as there are multiple instances of food industry having a significant influence over the HSR system, including the following:

- 1 From the outset the Ministerial objectives and principles for developing a front-of-pack labelling system stated that there was a desire to undertake a collaborative design process with 'industry, public health and consumer stakeholders'. And to this end a Technical Design Working Group was established with 4 of its 8 members being selected on the basis of their expertise and experience in industry, and one of those also co-chairing the Group (<http://foodregulation.gov.au/internet/fr/publishing.nsf/Content/frontofpackcommittee>).
- 2 At a Public Health Association of Australia meeting held on 27/11/17 in Canberra and entitled 'PHAA Health Star Rating Forum: Improving Health Star Rating: Exploring Origins of the algorithm and where to from here', the

first invited speaker addressing the topic was a food industry scientist who was introduced as having had a lead role in the developmental work behind the HSR concept and technical design.

- 3 The HSR system is one component of the Healthy Food Partnership. The Partnership includes a number of food industry representatives and from its inception has involved the Australian Food and Grocery Council, the peak advocacy agency for large food and beverage companies in Australia. In practical terms, food industry partnership arrangements have had a profound influence on the design and implementation of the HSR system.

We believe that the problems with the HSR system and the significant influence of the food industry over the HSR need to be more accurately reported.

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#### Conflict of interest

The authors have no conflict of interest to declare.

#### Authorship

All authors have contributed, written and reviewed the letter to the editor. All authors are in agreement with the manuscript and declare that the content has not been published elsewhere.

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[Correction added on 10 August 2018, after first online publication: The following affiliation has been removed: Public Health Division, Department of Health, Government of Western Australia.]

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## LETTER TO THE EDITOR

### CURRENT ENTERAL FEEDING PRACTICES IN PAEDIATRIC INTENSIVE CARE UNITS IN AUSTRALIA AND NEW ZEALAND: RESULTS FROM A SURVEY OF DIETITIANS

To the Editor:

We would like to add to the theme of a recent issue of *Nutrition & Dietetics* entitled 'Nutritional Care in the Life Cycle: Paediatric and childhood settings'. A prospective study<sup>1</sup> and recent surveys<sup>2, 3</sup> of nutritional practices in paediatric intensive care units (PICUs) across the globe have revealed inconsistencies but have drawn their information from a range of paediatric clinical care providers. In the interests of obtaining the perspective of Australian and New Zealand dietitians, permission was sought from the head of each paediatric nutrition and dietetic department in Australia and New Zealand with an intensive care unit (n = 8) to invite the PICU dietitian to participate in an online survey. The information targeted was the preferred route of enteral feeding (nasogastric (NG) vs nasojejunal (NJ)) and the placement techniques. Questions relating to fasting times pre- and post-extubation, presence of enteral nutrition policies and use of a nutrition team were included for comparison with clinical practice guidelines available at the time of the survey<sup>4</sup> for nutrition support of the critically ill child. Data on PICU bed numbers, dietetic staffing levels and number of patients requiring enteral feeding were also sought in the survey, and admissions per year and number of patients ventilated were obtained from ANZPICS 2015. Approval to undertake the research was obtained from the Princess Margaret Hospital Human Ethics Committee (approval number 2016020EP).

Responses from six sites were obtained from September 2016 to April 2017. Dietetic full-time equivalents (FTEs) ranged from <0.1 to 0.8, with median (range) bed number 22.5 (10–36) and FTE/bed from <0.01 to 0.03. Dietetic staff time allocated per admission ranged from <16 to 71 seconds and per ventilated patient from 38 to 132 seconds. In keeping with global research,<sup>1–3</sup> practices in Australian PICU also appear to be highly variable, apart from extubation fasting times (consistently 4 hours pre- and post-extubation). While all the represented PICU had some dietetic input, the existence of a nutrition support team (NST) was reported for two of the six sites, with only one of these involving a dietitian.

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Similarly, a survey of 47 Middle East and Asia-Pacific respondents, mainly PICU physicians, including Australian and New Zealand (n = 7), and representing 35 centres, found 9 (26%) to have an NST and 13 (37%) of centres to have the services of a dedicated intensive care dietitian.<sup>2</sup> In the present survey, a nutrition support policy was in place at four of the sites, however, one of these was limited to fluids, despite the presence of an NST involving a dietitian.

The dietitians who answered (n = 5) indicated that the NG route was preferred over NJ, with three sites using bedside placement, at least initially (n = 1), one site using radiological placement routinely and the remaining site indicating that it depended on the patient. The reasons for this route were not stated (n = 2), suits most patients (n = 1) and used unless the patient was not tolerating the feed (n = 2). Dietetic opinion regarding placement route preference related to NG being more physiological (n = 1), and able to be confirmed immediately after bedside placement (n = 1), while that from the site that placed the NG tube radiologically indicated that it depended on the patient.

This study is limited by the <100% response rate, because of the invitation not being passed on to one PICU dietitian and the inability to contact one ethics committee. Online surveys limit the detail that may be elicited by, for example, telephone interviews, which also reduce the likelihood of incomplete responses.

The evidence base for many aspects of nutrition support in PICU is not strong, yet nutritional costs contribute a small component of the total costs of the PICU and have the potential to reduce PICU length of stay, the major cost.<sup>5</sup> The most recent clinical guidelines for nutrition support of the critically ill child were published in September, 2017<sup>6</sup> and suggest that an NST, including a dedicated dietitian, be available. The evidence for this suggestion is limited to observational studies, however, the arguments in support of NST in paediatric units in general are over a decade old.<sup>7</sup>

NST and dietetic involvement in NST are not universally present in Australian/New Zealand PICUs. Dietitians are best placed to conduct nutrition assessment and facilitate optimal nutrient delivery and adjustment, the nominated strengths of a PICU NST.<sup>5</sup> It should be noted that the 2009 clinical guidelines included nutrition assessment and the formulation of a nutrition care plan where appropriate<sup>4</sup> so the justification for dietetic involvement in PICU is not new. Given the small number of dietitians working in this area in Australia and New Zealand, collaboration between dietitians who are involved in PICU NST and those who are not, could allow the barriers to NST formation to be addressed. Once established NST can follow the suggestions made by the European Society of Paediatric Gastroenterology, Hepatology and Nutrition Committee on Nutrition in 2005<sup>7</sup> and thus contribute to the evidence required to inform the development of nutrition support protocols in PICU.

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## Conflict of interest

The authors have no conflict of interest to declare.

## Authorship

BM collected the data as part of her PhD program. JS and GK supervised the PhD program. All authors were involved in planning the research, are in agreement with the manuscript and declare that the content has not been published elsewhere.

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