Original Research

IS THERE A RELATIONSHIP BETWEEN FOOD KNOWLEDGE, DIETARY KNOWLEDGE AND BODY MASS INDEX WITHIN THE TERTIARY STUDENT POPULATION?

Jessica Taylforth and Megan Gibbons

Institute of Sport, Exercise & Health, Otago Polytechnic, Dunedin,New Zealand.

INTRODUCTION

In 2018, New Zealand (NZ) has the third highest rate of obesity in the Organisation for Economic Cooperation and Development (OECD) member countries, and the prevalence of this disease in NZ is increasing (Ministry of Health, 2016; Organisation for Economic Cooperation and Development, 2017).The 2015/16 New Zealand Health Survey found that more than three in ten adults (32%) were obese, a 5% increase since 2006/07 (Ministry of Health, 2016).

The Body Mass Index (BMI) scale is a measure of weight adjusted for height, and is calculated by dividing weight in kilograms by the square height in metres (Ministry of Health, n.d.).The BMI scale is used nationally and internationally as a useful population-level indicator of excess body weight (World Health Organisation, 2016). According to the World Health Organisation's BMI classification, a person can be classified as underweight (BMI <18.50), in the normal range (BMI 18.50-24.99), overweight (BMI >25.00) or obese (BMI >30.00) (World Health Organisation, 2000).

As a person's BMI increases, so does their risk of developing obesity-related diseases (National Heart, Lung, and Blood Institute, 2012). Obesity is currently one of the leading causes of premature death in adults (Bauer, Briss, Goodman, & Bowman, 2014) and has been shown to be more prevalent in places where people have a low level of education or low income (Bauer et al., 2014; Sobal & Stunkard, 1989).

Studies conducted in the United Kingdom and United States suggest that as a young adult, a student's tertiary years are period in which substantial weight gains can be made (Crombie, Ilich, Dutton, Panton, & Abood, 2009; Finlayson, Cecil, Higgs, Hill, & Hetherington, 2012). A meta-analysis (Vella-Zarb & Elgar, 2009) found that first-year tertiary students gain on average 3.86kg, followed by a slow and steady increase in weight in the following years of study (Gores, 2008). Given that this is a period where young people are setting themselves up for the rest of their lives, their careers, life goals, self-esteem and family could be impacted by this weight gain. It has has been suggested that this increase in weight is mainly due to low levels of nutrition knowledge and cooking skills, and that there is a need for strategies to address this issue (Devaux, Sassi, Cecchini, Borgonovi, & Church, 2011; Sakamaki, Toyama, Amamoto, Liu, & Shinfuku, 2005).

It has been observed that, in general, tertiary students do not consume the recommended amount of fruit and vegetables, but have a high intake of saturated fat and alcohol (Deliens et al., 2014). Furthermore, unhealthy habits developed by students in their tertiary years generally persist into older adult life (Ganasegeran, Al-Dubai, Qureshi, Al-Abed, Rizal, & Aljunid, 2012).

The aim of our research was to investigate the relationship between food knowledge (FK), dietary knowledge (DK) and BMI in the tertiary student population. This project was undertaken in order to determine if there were significant correlations between these factors. A correlation would indicate that implementing strategies to increase tertiary students' nutritional knowledge (through nutrition education) could be effective in reducing the prevalence of overweight and obesity in NZ. The working hypothesis for this study predicted a correlation between DK and FK (both independently and collaboratively as total knowledge) with the BMIs of tertiary students.

The definitions of FK and DK are inconsistent within the literature. For the purposes of this study, FK refers to a person's ability to accurately identify common fruits and vegetables, whereas DK refers to one's knowledge of current national dietary guidelines and recommendations. Total knowledge (TK) was the term used to describe the score that participants achieved on both the DK and FK survey combined.

In NZ there is no existing published research that investigates the relationship between FK and DK, on the one hand, and BMI. Existing research is limited to overseas studies that examine either FK or DK independently – but never both together or in comparison.

METHODS

Study Design

This study utilised surveys and quantitative measures to examine the relationship of dietary knowledge (DK) and food knowledge (FK) with body mass index (BMI), within the tertiary student population.

Participants

This study recruited participants who met the following eligibility criteria: currently enrolled in either Otago Polytechnic or Otago University; aged between 18 and 40; and not using a pacemaker or any other electrical device aiding body function (due to the potential risk of device failure during body composition assessment). The study population comprised 52 participants.

A homogenous purposive sampling technique was used to recruit participants. This was done by advertising in local media commonly read by the target student population. Efforts were made to recruit participants from outside the researcher's school by emailing student halls of residence and by placing poster adverts in student association premises.

Procedures

Consultation with the Otago Polytechnic kaitohutohu was undertaken prior to the commencement of this research. Ethical approval was sought and granted on 7 June 2017. Participants were each privately individually assessed under the guidance and supervision of the researcher, at Otago Polytechnic. Informed consent was gained from all participants prior to commencing pre-screening. Eligible participants completed the DK survey and the FK survey. Height and body composition were measured. Following assessment, each participant received a copy of their results and were provided with a tool to assist in interpreting them.

Following assessment, nothing further was required of the participant. Participants received a summary of the study results if they had indicated that they wanted this by ticking the corresponding box on the participant consent form.

Quantitative data collected during assessment included height (cm), weight (kg), BMI ($kg.m^2$), age (years), DK score,

FK score and total knowledge (TK) score. Demographic data collected during assessment included participants' gender, ethnicity, tertiary institution and years in tertiary study.

Equipment

Survey forms were piloted on volunteers (*n*=4) to assess the flow, language and intention of questions. As result of participant confusion, four images in the FK survey were removed and substituted by more suitable images. It was identified during pilot testing that the Tanita scales (used to measure body composition) were inaccurate due to a calibration problem. The In-Body scales were used as a substitute.

To improve the accuracy and reliability of the data, measurements of height and body composition were assessed by the researcher. The equipment required included a tape measure (for height measure) and In-Body machine (to measure body composition); both items were provided by the Otago Institute of Sports and Adventure (OISA). An iPad (provided by OISA) was used by participants to complete the participant screening form and the surveys. Google Forms were used to create and deliver these.

The DK survey consisted of ten multiple choice questions derived from the Eating and Activity Guidelines for New Zealand Adults (Ministry of Health, 2015), compiled for health practitioners and others who provide advice on nutrition and publicly accessible online (Ministry of Health, 2015). The FK survey consisted of 30 multiple choice questions where participants were required to identify each fruit and vegetable pictured by name.

Data Management

Given the face-to-face nature of the data collection, it was not possible to anonymise each participant. However, de-identification was achieved by allocating each participant with a number to which their data was recorded. These numbers were also added to the relevant participant's consent form, but stored separately.

Data Analysis

Standard descriptive statistics including medians, ranges and percentages were used to describe the variables (age, gender, ethnicity, tertiary institution, year of tertiary study, DK score, FK score, TK score and BMI).

Analysis to compare the relationship between variables (BMI, DK, FK, and TK) was completed using Pearson's correlation coefficient, which identifies the linear relationship between the examined variables; statistical significance was set at a p-value ≤0.05.

Scaling

A score of 1 or 0 was given for each survey answer, depending on whether it was correct or not. Participants' scores were then scaled to determine their level of knowledge (see Table 1). Participants' BMI scores were scaled according to the World Health Organisation's BMI classification to determine whether participants were classified as underweight (<18.5 BMI), normal (18.5-24.9), overweight (25.0-29.9), or obese (≥ 30.0; World Health Organisation, n.d.).

BMI (kg/m²)	Underweight *<18.5 kg/m²*	Normal *18.5 – 24.9 kg/m²*	Overweight *25.0 – 29.9 kg/m²*	Obese *≥30.0 kg/m²*
n	1	25	22	4
%	2	48	42	8

Table 1: BMI Results by BMI Classifications

RESULTS

Sample Demographics

A total of 52 participants were assessed in the study. The sample comprised of 29 females (56%) and 23 males (44%), and the median age of participants was 22 years. Thirty-three of the participants identified themselves as NZ European (63%), six identified as NZ Maori (12%), four identified as Pasifika (8%), three as Asian (6%), and six as Other (12%). Twenty-eight participants (54%) were students of Otago Polytechnic (OP) and 24 (46%) were students of Otago University (OU). Of the participants, four were in their first year of tertiary study (8%), 12 were in their second year (23%), 19 were in their third year (37%), eight were in their fourth year (15%), and nine had completed >4 years of tertiary study (17%).

Body Mass Index

The study sample represented a range of body mass index (BMI) scores (17.9 – 36.7 kg/m^2), with a median BMI score of 25 kg/m^2. Results shown in Table 2 reveal that one (2%) of the participants was underweight (<18.5 kg/m^2), most (n = 25; 48%) were in the normal range (18.5 – 24.9 kg/m^2) or were overweight (n = 22, 42%) (25.0 – 29.9 kg/m^2), and four (8%) were obese (≥30.0 kg/m^2).

Subscale	Median	Lowest	Highest	Range
DK Score	5	4	7	3
FK Score	29	20	30	10
TK Score	34	26	37	11

* Maximum score on each subscale = 10 ** Maximum score on each subscale = 30 *** Maximum score on each subscale = 40

Table 2: Knowledge Scores

Knowledge Scores

As Table 2 shows, the median total knowledge (TK) score was 34. Of the 52 participants, all scored ≥26/40. Fifteen (29%) participants scored between ≥25 and ≤32 (very good TK score) and 37 (71%) of participants scored between ≥33 and <40 (excellent TK score). On average, participants' FK scores were higher than their DK scores.

The median score for DK was 5. Of the 52 participants, one (2%) scored between 0 and 2 (poor DK score), seven (14%) scored either a 3 or 4 (fair DK score), 33 (63%) scored either a 5 or 6 (good DK score), 11 (21%) scored a 7 (very good DK score), and no participants scored ≥8 (see Table 2). These scores represent the level of knowledge that participants had of the NZ Ministry of Health's dietary guidelines as measured by this survey. An impressive 42 (81%) participants correctly answered the question, "How many servings of fruit and vegetables are adults recommended to eat per day?"

Although, on average, DK was shown to be at a good level, only six (12%) participants correctly answered the question, "What is one serving of cooked grain food equivalent to?," and only three (6%) correctly answered the question, "How many servings of grain foods are adults recommended to eat per day?" These results indicate that while the sample had a high level of knowledge of the dietary guidelines for fruits and vegetables, they showed a low level of knowledge of grain foods.

The median score for FK was 29. Of the 52 participants, all scored ≥20, three (6%) scored between ≥19 and ≤24 (very good FK score), and 49 (94%) scored ≥25 (excellent FK score). These scores represent the excellent ability of

participants to identify common fruits and vegetables as measured by this survey.

Table 3 demonstrates the median scores obtained by participants for DK, FK and TK according to their BMI classification. These results show that obese individuals and those of healthy weight have comparable levels of DK, FK and thus TK.

Correlations

Pearson's correlation coefficient was used to measure the strength of the linear relationship between the variables. As Table 5 and Figure 3 show, no significant correlation was found between TK scores and BMI (r = -.080, P = 0.571). Pearson's correlations were performed on DK scores and FK scores independently. No significant correlations were found between DK scores and BMI (r = -.119, P = 0.401) or between FK scores and BMI (r = -.037, P = 0.795) (see Table 4).

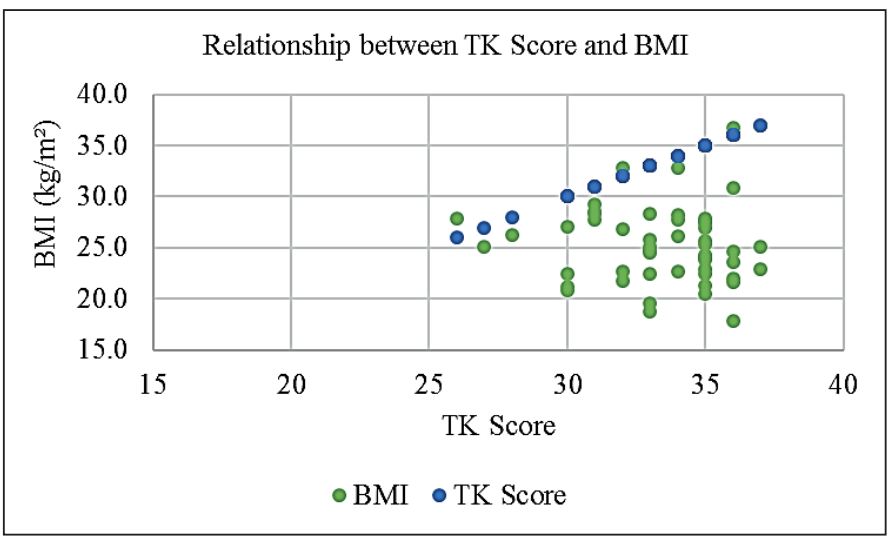

Figure 1: Scatter plot graphy demonstrating the relationship between TK Score and BMI

Subscale	BMI classification, median			
	Underweight n = 1	Normal n = 25	Overweight n = 22	Obese n = 4
DK score*	7	6	5	6
FK score**	29	28.5	28	29
TK score***	36	34.5	33	35

* Maximum score on each subscale = 10 ** Maximum score on each subscale = 30 *** Maximum score on each subscale = 40

Table 3: Knowledge Scores by BMI classification (n=52)

Measure	DK Score	FK Score	TK Score
Pearson's correlation coefficient	-0.119	-0.037	-0.080
P- value	0.401	-0.795	0.517

Table 4: Correlations between Knowledge Scores and BMI

DISCUSSION

This study was designed to examine the relationship of dietary knowledge (DK) and food knowledge (FK), independently, and combined as total knowledge (TK), with body mass index (BMI) within a tertiary student population. The results demonstrated no significant correlations between tertiary students' knowledge of national dietary guidelines and their ability to identify common fruits and vegetables, on the one hand, with their BMI scores.

The study findings failed to support the research hypothesis which predicted a correlation between DK and FK (both independently and combined as TK) and BMI. This is likely to be due to the sample group being a well-educated population, whose food knowledge was high irrespective of BMI levels. This result differs from what has been found previously in other parts of the world, and further research is needed in this area (Devaux, Sassi, Cecchini, Borgonovi, & Church, 2011; Sakamaki, Toyama, Amamoto, Liu, & Shinfuku, 2005).

To ensure that the sample group was a fair representation of the total student population, respondents' gender and ethnicity statistics were compared to Otago University and Otago Polytechnic student demographics. Of Otago University's 2016 student cohort, 58% were female and 42% were male (OUSA, personal communication, October 24, 2017) – almost identical to that of the sample group. Of Otago Polytechnic's 2016 student cohort, 64% identified themselves as NZ European and 9% identified themselves as NZ Maori (OPSA, personal communication, October 24, 2017) – very similar to the make-up of the sample group. We did not consider ethnicity as a factor in the study results, as the purpose of understanding the demographics was to generalise the results. Further research could include the impact of ethnicity on food selection and knowledge in this population.

Our results indicated that overweight and obese individuals and those of healthy weight have comparable levels of DK and FK. This suggests reasons other than individuals' level of knowledge that account for the higher BMI scores of the overweight and obese participants. This assumption is supported by the literature, which suggests that nutritional knowledge alone is not a substantial risk factor in the development of obesity (Wardle, Parmenter, & Waller, 2000; Wright & Aronne, 2012). Stark (2013) makes the crucial point that nutritional education alone, although essential, is typically insufficient to facilitate behaviour change due to its failure to specifically address the personal, behavioural, and environmental barriers to healthy eating (Stark, 2003).

As measured by the BMI scale, most participants were found to be of normal body weight (n = 25; 48%). However, a high proportion of participants were overweight (n = 22; 42%), which corresponds with the findings of research conducted on a much larger scale (Peltzer, Pengpid, Samuels, Özcan, Mantilla, Rahamefy, & Gasparishvili, 2014). This proportion of overweight tertiary students is particularly concerning in light of recent literature presenting evidence that a person's risk of unhealthy weight gain will continue to increase with age (Al-Kilani, Waly, & Yousef, 2012; Gores, 2008). People who are overweight in their tertiary years are expected to gain an additional 1.9kg per decade (Meeuwsen, Horgan, & Elia, 2010), further increasing their risk of developing obesity and obesity-related diseases in the future (National Heart, Lung, and Blood Institute, 2012).

We found that participants' knowledge of dietary guidelines (DK) was inferior to their ability to identify common

fruits and vegetables (FK). From the DK survey, 42 (81%) participants were correctly able to identify the number of servings of fruit and vegetables that adults are recommended to consume per day. This may be due to the efforts of the New Zealand charitable trust 5+ A Day, which actively promotes the Ministry of Health's (2015) recommendation to 'Eat at least 5 servings per day: at least 3 servings of vegetables and at least two servings of fruit' (p. 13).

Of most concern was the participants' level of DK revealed in the two questions relating to grain foods. Although overall, participants' DK was found to be good, only six (12%) participants could correctly identify what a serving size of cooked grain is equivalent to, and only three participants (6%) were able to correctly identify the number of servings of cooked grains that adults are recommended to eat per day. It is possible that this low level of knowledge is linked to current trends within the diet industry. The paleo and the ketogenic diets are two well-publicised diets which have demonised carbohydrates as 'toxic,' regardless of their source (WebMD, n.d.), causing the general public to develop a fear of this essential macronutrient (WebMD, n.d.). In contrast, research-based national guidelines developed by the Ministry of Health (2015) emphasise the benefits of consuming carbohydrates from particular sources, stating that 'Eating whole grain and high fibre grain foods is linked with a lower risk of cardiovascular disease, type 2 diabetes, weight gain and some cancers' (p. 15). It is important that educators and public health workers are made aware of the low level of tertiary students' knowledge of the guidelines and recommendations for grain foods specifically.

The sample group's ability to identify common fruits and vegetables (FK) was found to be excellent. This again could be due to the successful promotion of the 5+ A Day program throughout New Zealand, with a particular focus on primary schools (5plusaday, n.d.). The program provides curriculum-linked resources promoting awareness, understanding and knowledge of the importance of eating "five plus" servings of fruit and vegetables per day (5plusaday, n.d.). The program's resources are produced and distributed free to educators and health professionals. The program not only promotes consumption recommendations, but it also increases awareness and knowledge of common fruits and vegetables through visual and practical resources and activities (5plusaday, n.d.). As the median age of participants in this study was 22, it is likely that the sample population had participated in the 5+ A Day program throughout their primary school education.

Limitations of the study

Although participants were recruited from two separate tertiary institutions in Dunedin, the external validity of the study is compromised due to the potential for self-selection bias, since participants volunteered to take part. The invasive face-to-face nature of the assessment, and the potentially sensitive data collected, may have also deterred eligible participants from volunteering. The multiple-choice method of surveying used to assess knowledge placed limited emphasis on the practical dissemination of knowledge and allowed for participants to guess answers if they were unsure. It is also important to note that the findings may be subject to bias, given the small sample size and the inclusion of participants who were enrolled in a course that included a nutrition education component.

CONCLUSIONS

Within the sample of tertiary students chosen, this study found no significant correlation between total knowledge (TK) and body mass index (BMI). Overweight and obese participants were found to have comparable levels of TK compared to participants of a healthy weight. Although most participants were of normal weight, a large proportion of participants were overweight. The FK of participants was excellent and although DK levels were good, the study revealed a need for increased promotion of the dietary guidelines for grain foods. We recommend that future research continues to focus on developing a preventative approach to obesity, utilising a longitudinal design and reliable, well-validated measures of DK and FK. It would also be desirable to examine the effects of additional factors, such as years of study completed and ethnicity, on changes in students' BMI during their tertiary education years.

CORRESPONDING AUTHOR

Dr Megan Gibbons: Otago Polytechnic; Email: megan.gibbons@op.ac.nz; Tel: +64397727187

REFERENCES

Al-Kilani, H., Waly, M., & Yousef, R. (2012). Trends of obesity and overweight among college students in Oman: A cross sectional study. *Sultan Qaboos University Medical Journal*, *12*(1), 69–76.

Bauer, U. E., Briss, P. A., Goodman, R. A., & Bowman, B. A. (2014). Prevention of chronic disease in the 21st century: Elimination of the leading preventable causes of premature death and disability in the USA. *The Lancet*, *384*(9937), 45–52.

Crombie, A. P., Ilich, J. Z., Dutton, G. R., Panton, L. B., & Abood, D. A. (2009). The freshman weight gain phenomenon revisited. *Nutrition Reviews*, *67*(2), 83–94.

Deliens, T., Clarys, P., De Bourdeaudhuij, I., & Deforche, B. (2014). Determinants of eating behaviour in university students: A qualitative study using focus group discussions. *BMC Public Health*, *14*(1), 1–12.

Devaux, M., Sassi, F., Cecchini, M., Borgonovi, F. & Church, J. (2011). Exploring the relationship between education and obesity. *OECD Journal: Economic Studies*, *2011*(1), 1–40.

Finlayson, G., Cecil, J., Higgs, S., Hill, A., & Hetherington, M. (2012). Susceptibility to weight gain. Eating behaviour traits and physical activity as predictors of weight gain during the first year of university. *Appetite*, *58*(3), 1091–1098.

Ganasegeran, K., Al-Dubai, S. A., Qureshi, A. M., Al-Abed, A. A., Rizal, A. M., & Aljunid, S.M. (2012). Social and psychological factors affecting eating habits among university students in a Malaysian medical school: A cross-sectional study. *Nutrition Journal*, *11*(1), 1–7.

Gores, S. (2008). Addressing nutritional issues in the college-aged client: Strategies for the nurse practitioner. *Journal of the American Academy of Nurse Practitioners*, *20*(1), 5–10.

Ministry of Health. (2015). *Eating and activity guidelines for New Zealand adults*. Retrieved from http://www.health.govt.nz/system/files/documents /publications/eating-activity- guidelines-for-new-zealand-adults-oct15_0.pdf

Ministry of Health. (2016). *Annual update of key results 2015/16: New Zealand health survey*. Retrieved from http://www.health.govt.nz/publication/annual-update-key-results-2015-16-new-zealand-health-survey

Ministry of Health. (n.d.). *Body size*. Retrieved from http://www.health.govt.nz/our-work/populations/maori-health/tatau-kahukura-maori-health-statistics/nga-tauwehe-tupono-me-te-marumaru-risk-and-protective-factors/body-size

Meeuwsen, S., Horgan, G. W., & Elia, M. (2010). The relationship between BMI and percent body fat, measured by bioelectrical impedance, in a large adult sample is curvilinear and influenced by age and sex. *Clinical nutrition*, *29*(5), 560–566.

National Heart, Lung, and Blood Institute. (2012). *What are the health risks of overweight and obesity?* Retrieved from https://www.nhlbi.nih.gov/health/health-topics/topics/obe/risks

Organisation for Economic Cooperation and Development. (2017). *Obesity update 2017*. Retrieved from http://www.oecd.org/health/obesity-update.htm

Peltzer, K., Pengpid, S., Samuels, T., Özcan, N. K., Mantilla, C., Rahamefy, O. H., & Gasparishvili, A. (2014). Prevalence of overweight/obesity and its associated factors among university students from 22 countries. *International Journal of Environmental Research and Public Health*, *11*(7), 7425–7441.

Sakamaki, R., Toyama, K., Amamoto, R., Liu, C. & Shinfuku, N. (2005). Nutritional knowledge, food habits and health attitude of Chinese university students – A cross sectional study. *Nutrition Journal*, *4*(1), 4.

Sobal, J., & Stunkard, A. (1989). Socioeconomic status and obesity: A review of the literature. *Psychological Bulletin*, *105*(2), 260–275.

Stark, L. J. (2003). Can nutrition counselling be more behavioural? Lessons learned from dietary management of cystic fibrosis. *Proceedings of the Nutrition Society*, *62*(4), 793–799.

Vella-Zarb, R. & Elgar, F. (2009). The 'freshman 5': A meta-analysis of weight gain in the freshman year of college. *Journal of American College Health*, *58*(2), 161–166.

Wardle, J., Parmenter, K., & Waller, J. (2000). Nutrition knowledge and food intake. *Appetite*, *34*(3), 269–275.

WebMD. (n.d.). *The low-carb craze continues*. Retrieved from https://www.webmd.com/diet/features/the-low-carb-craze-continues#1

World Health Organisation. (2000). *Obesity: Preventing and managing the global epidemic*. Retrieved from http://apps.who.int/bmi/index.jsp?introPage=intro_3.html

World Health Organisation. (2016). *Obesity and overweight*. Retrieved from http://www.who.int/mediacentre/factsheets/fs311/en/

World Health Organisation Europe. (n.d.). *Body mass index – BMI*. Retrieved from http://www.euro.who.int/en/health-topics/disease-prevention/nutrition/a-healthy-lifestyle/body-mass-index-bmi

Wright, S. M., & Aronne, L. J. (2012). Causes of obesity. *Abdominal Radiology*, *37*(5), 730–732.