Knowledge, practices, and perceptions of nut metabolisable energy on nutrition labels in Australia: Consumers' and stakeholders' perspectives

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Ethical standards disclosure: This study was conducted according to the guidelines laid down in the Declaration of Helsinki and all procedures involving research study participants were approved by the University of Wollongong Health and Medical Human Research Ethics Committee (2022/341). Written and verbal informed consent was obtained from all subjects/patients. Verbal consent was witnessed and formally recorded.

Abstract

Objective: Nut consumption is low, with concern regarding weight gain a barrier to intake. However, evidence indicates no association between nut consumption and body weight. The metabolisable energy of nuts may partly explain this phenomenon. This study aims to qualitatively explore perceptions of presenting nut metabolisable energy on nutrition labels, and the potential influence this may have on consumption.

Design: Semi-structured focus groups and interviews, with an inductive, reflexive approach to thematic analysis.

Setting: Online (Australia).

Participants: 18 years or older, with either no formal nutrition education (consumer group) or formal training and working in nutrition/dietetics, public health, food industry, food regulation, or nut growing (stakeholder group).

Results: Four focus groups and nine interviews consisting of 20 participants (n=8 consumers, n=12 stakeholders) in total were conducted. Five major themes were generated: i) knowledge of nuts varies, and the healthfulness of nuts is conditional on use and preparation, ii) nuts are versatile in the diet; intake is low, iii) consumers perceive over-eating nuts leads to weight gain, while stakeholders consider the whole dietary pattern, iv) nutrition labelling is confusing for consumers and needs to be transparent and positively framed, if used, and v) knowing nut metabolisable energy will have limited perceived impact on nut consumption and advice, and is dependent on the individual and product.

Conclusions: The findings suggest that perceptions of presenting nut metabolisable energy on labels are multi-layered, indicating this strategy may not be straightforward in resolving concerns about weight. Other strategies should be considered to promote nut consumption.

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Introduction

Nuts are nutritious and provide several health benefits [1-5], but intake remains low, partly due to concerns among consumers and health professionals about their high energy content contributing to weight gain [6-14]. However, such concerns are not supported by scientific evidence [5, 15, 16]. The lack of association between nut intake and body weight may be partially explained by their lower-than-expected (up to 30% lower) metabolisable energy due to incomplete fat absorption [17]. Therefore, strategies that address these misconceptions, such as informing consumers of metabolisable energy of nuts, may promote nut consumption.

In Australia, nutrition information on packaged food and beverage products is regulated by Food Standards Australia New Zealand (FSANZ) and can be presented as nutrition information panels (NIPs) and front-of-pack (FOP) labels, among other elements [18]. Currently, in Australia and other countries such as the US and the European Union, the energy values on labels must be determined using Atwater factors (17kJ/gram of carbohydrate and protein, 37kJ/gram of lipid, and 29kJ/gram of alcohol) [19-21]. However, this provides an estimation of the energy content and may not represent metabolisable energy, or the energy that is absorbed by the body during digestion. While some countries such as the US allow the analysed energy content in NIPs to be up to 20% above the labelled energy value [22], there is currently no allowable margin of error for reporting energy content in NIPs in Australia [20]. Therefore, the inclusion of nut metabolisable energy in NIPs and FOP labels should be explored in Australia.

However, limited research explores perceptions of nut metabolisable energy labelling and the potential impact on nut consumption. We previously conducted an online survey to investigate perceptions of communicating metabolisable energy of nuts on nutrition labels (Nikodijevic et al., in press [23]). This current study aimed to expand on the survey findings by qualitatively exploring perceptions among consumers and stakeholders.

Methods

Study design, researcher position and reflexivity

A qualitative study design utilising focus groups and key informant interviews was conducted among nut consumers and stakeholders. Online focus groups and interviews explored the perceptions of nuts and nut butters, barriers to intake, and nutrition labelling.

Thematic analysis of the data was inductive and reflexive, and the study's underpinnings draw on constructs of the Knowledge-to-Action (KTA) framework [24]. The KTA framework consists of two cycles: knowledge creation and an action cycle. It details a structured approach that translates knowledge to practice. This framework was chosen to

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explore how knowledge about nut metabolisable energy may influence consumer behaviour among a diverse range of participants, including consumers, health professionals, and nut growers. Concepts explored what participants thought about the energy content of nuts, if they were aware of their lower metabolisable energy, and whether nut metabolisable energy would have a perceived impact on nut consumption.

All authors were Accredited Practising Dietitians with varying levels of experience in academia and clinical practice, and were included in the research team due to their experience in nut research, energy balance, nutrition labelling and qualitative research. The moderator (C.J.N) was a PhD candidate at the time of the study, with previous nut-related research experience, and had experience in providing nutritional care to consumers in a clinical context. Throughout the study, authors discussed their positions and how they may influence data collection and analysis. Reflexive practice was used to identify and manage potential biases that may arise due to the authors' positions. The moderator kept notes throughout the data collection and analysis phases. Discussions between the moderator and observer (E.P.N, C.M or S.A) occurred following each session to debrief and reflect on the conduct and results of sessions, which helped improve future sessions (such as by rewording questions).

Participant recruitment

Participants were recruited via email from respondents to the prior online survey in 2023 who were interested in a focus group or interview (Nikodijevic et al., in press [23]). Survey respondents were recruited using social media, e-newsletters, and community flyers distributed in the Illawarra region of New South Wales and the main University of Wollongong campus. Eligible respondents needed to be living in Australia and be aged 18 years or older. The design of the online survey is detailed elsewhere (Nikodijevic et al., in press [23]). Briefly, consumers included in this study had no formal nutrition training, while stakeholders had formal nutrition training and were working as a dietitian, nutrition professional, nutrition and food science researcher, public health professional, food industry professional, food regulator, or nut grower. As an incentive, a prize draw to win one of five $50 supermarket vouchers was established. Ethics approval was obtained from the University of Wollongong Health and Medical Human Research Ethics Committee (2022/341). All participants provided written informed consent prior to participation. No participants refused to participate in or dropped out of this study.

Data collection

All focus groups and key informant interviews were conducted online using Zoom (version 5.17.5; https://zoom.us). Focus groups included two to four participants per group, while key

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informant interviews were conducted one-on-one. The allocation of participants to the focus groups or interviews was based on participant availability. A demographic questionnaire collected information about age, gender, education, employment status, and geographical area of residence, as well as profession, highest qualification, years working in current role, and geographical area of work for stakeholder participants.

Focus groups and interviews were conducted by one moderator (C.J.N, woman), and one observer (E.P.N, C.M or S.A, all women) present where possible. The moderator was the primary investigator and a novice qualitative researcher, while E.P.N had prior experience in qualitative research and focus group methodology. The remaining two observers (C.M and S.A) were novice qualitative researchers. The moderator and observers were trained dietitians with two to 15 years' experience. The questions followed a semi-structured approach, with follow-up questions asked as appropriate (Supplementary Material 1). Questions were pilot tested with a group of four consumers and modified according to feedback. As outlined by Krueger and Casey [25], each session began with an introduction about the process. Participants were informed in advance of the topics of the session. No repeat interviews were carried out.

Questions were developed by the authors. Briefly, the questions explored nut intake (consumers only), perceptions of nuts and nut butters, current target for nut intake, barriers to nut intake (consumers only), relationship with body weight, metabolisable energy of nuts and the perceived impact this has on consumption, and nutrition labelling (using the mock packaging slides). Additionally, for stakeholders, how nut intake is recommended or promoted was also explored. The term "metabolisable energy" was defined as the amount of energy our body can absorb when we eat food prior to the respective questions. Participants were then asked if the lower metabolisable energy of nuts would impact consumption or product choice. Participants were shown examples of mock packaging for plain nuts, a nut butter, and a nut-containing breakfast cereal, with either Atwater or metabolisable energy displayed (Supplementary Material 2). A metabolisable energy value of 10% lower than Atwater energy was displayed in packaging for plain nuts and nut butters to reflect the difference in metabolisable energy based on nut types and form (ranging from 5% to 26% lower than Atwater). The breakfast cereal example showed a metabolisable energy of 1% lower than Atwater to reflect the small proportion of nuts within the product. Finally, participants were shown examples of nutrition labelling (Supplementary Material 2) and asked to choose their preference and/or suggest other ideas.

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All focus groups and interviews were recorded using Zoom and transcribed using Otter Pro (version 3.45.1-240308; https://otter.ai) software. Data cleaning consisted of source data verifying the transcripts to ensure verbatim transcription and accuracy [26]. The primary investigator (C.J.N) compared the Otter transcripts to the respective Zoom recordings (the source data). Data cleaning provided a first opportunity for data immersion and to record initial thoughts, as recommended by Braun and Clarke [27].

Data analysis

All investigators were Accredited Practising Dietitians, with two (E.P.N and Y.C.P, both women) having previous experience in qualitative research, while the remaining (S.Y.T [man] and C.J.N [woman]) were novices. Three investigators (E.P.N, Y.C.P and S.Y.T) hold a PhD in nutrition and dietetics and worked in academia at the time of the study. The final investigator (C.J.N) previously obtained a Bachelor degree in nutrition and dietetics and was undertaking a PhD at the time of the study. Inductive, reflexive thematic analysis of the transcripts was conducted by the primary investigator (C.J.N) as outlined by Braun and Clarke [27]. In line with the recommendations of Braun and Clarke [28], data saturation was not consistent with reflexive thematic analysis and checks were not implemented in this study. Coding was reflexive and systematic to increase robustness during this stage. Codes were stored and managed using NVivo software (release 1.7.1, https://lumivero.com/products/nvivo/) and were gathered to form potential themes. A second researcher (E.P.N) independently generated codes and themes for two transcripts, which were discussed with the primary investigator before the primary investigator (C.J.N) coded the remaining transcripts. A coding tree was developed using NVivo and themes were finalised and agreed upon by all investigators through discussion. Quotes are presented to demonstrate each theme, deidentified and labelled according to stakeholder group (e.g. DIET for nutritionist/dietitian), participant age (e.g. 4655 for 46-55y), gender (e.g. F for female/woman), and number (e.g. DIET4655F1). This study is reported according to the COnsolidated criteria for REporting Qualitative research (COREQ) checklist [29], provided in Supplementary Material 3.

Results

Participant demographics

Four focus groups and nine key informant interviews were conducted with 20 participants. Fifteen (75%) were female/women and 12 participants (60%) were aged 26 to 45 years. Focus group duration varied 44 to 54 minutes, while interviews ran 25 to 44 minutes. Forty per cent of participants were consumers and the remainder were key stakeholders (Table 1).

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Themes

Five major themes were generated and are discussed below. Illustrative quotes for each theme are presented in Tables 2 – 6. To allow for comparison between the participant groups, the consumer perspective and stakeholder perspective are presented within each theme.

Theme 1: Knowledge of nuts varies, and the healthfulness of nuts is conditional on use and preparation

Consumer perspective

Consumers demonstrated a basic understanding of nuts, including identifying nuts and nut butters and some nutrients they provide. Consumers acknowledged that nuts can be a healthy food, but also believed that there were less healthy nuts, depending on the nut type and how they were processed. For example, raw, organic, or unprocessed nuts were viewed as healthier than nuts that were salted or flavoured, or processed into nut butters (Table 2). When questioned about the serve size of nuts, most reported "a handful" as appropriate. When participants were informed that for many foods, the human body is unable to digest and absorb all of the energy contained, consumers thought the amount of available energy from nuts varied from about half to all of the energy.

Stakeholder perspective

Compared with the consumer group, stakeholders demonstrated a higher level of knowledge regarding nuts. A variety of stakeholder types were able to identify key nutrients and relationships between nut intake and health. Stakeholders believed that nuts can be included in a healthy pattern of eating and thought of nuts and nut butters as convenient and versatile foods. However, stakeholders made similar comments to consumers regarding the processing of nuts, emphasising raw, unsalted nuts for consumption as opposed to highly processed nuts or nut-containing discretionary products (Table 2). They correctly identified "30 grams per day" as the recommended serve size and frequency for nut consumption, though many noted that "a handful" or a "quarter cup" was an easier message. The term 'metabolisable energy' was familiar to stakeholders and most believed that the metabolisable energy of nuts was less than 100%. Some recalled learning this information and noted that the high fibre content contributes to the accessibility of fats.

Theme 2: Nuts are versatile in the diet; intake is low

Consumer perspective

Many consumers acknowledged that nuts can be included in the diet in a variety of ways. Consumers believed nuts were a tasty food and that this was an enabler to intake. Other enablers included prioritising a healthy diet and choosing more affordable nut types and

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products. Some intended but failed to include a handful of nuts every day in their diet, despite nuts being a versatile food and easy to eat more than one handful in one sitting (Table 3). The most common barriers to nut intake were the fat content and the potential for weight gain. Consumers were aware of the high fat and kilojoule content of nuts, and this combined with their "more-ish" (i.e. palatable) nature caused concern for weight gain. The high cost of some nuts was also a barrier, however consumers acknowledged price variations, and some affordable options are available. Other barriers to regular nut intake included disliking the taste, not being allowed in their children's school, not being in the habit of buying or eating nuts, not common to the participant's culture, having a busy lifestyle that restricts snack occasions, and a preference for larger meals as opposed one handful of nuts.

Stakeholder perspective

Like the consumer group, stakeholders also perceived nuts to be a versatile food in the diet. Nuts were viewed as a convenient snack option, as well as being incorporated into products. Stakeholders reported that the 30-gram recommendation is achievable; however, due to the variety of foods in a diet, it's unlikely that consumers choose nuts every day. Stakeholders also reported that taste, choosing more affordable nut types, and having discretionary income were other enablers for consumers. Although some believed that nuts were easy for consumers to eat, many agreed that nuts are "under-consumed", and most consumers do not eat 30 grams per day (Table 3). Probable barriers were similar to those reported by consumers, including the perceived high cost and the belief that nuts are unhealthy or lead to weight gain. However, stakeholders also identified a range of other potential barriers to intake, such as disliking the taste, being allergic to nuts, having poor dentition, nuts being forgotten or viewed as a boring food, and consumers not being in the habit of buying or eating nuts, or not aware of how to add nuts to the diet.

Theme 3: Consumers perceive over-eating nuts leads to weight gain, while stakeholders consider the whole dietary pattern

Consumer perspective

Consumers emphasised the importance of portion control. They believed that small amounts of nuts were considered healthy, and a 30-gram portion of nuts would not affect their body weight. However, consumers acknowledged that nuts are palatable and easy to over-eat, and too many nuts would contribute to weight gain. Eating more than one handful of nuts per sitting was perceived to be "overdoing it" due to the high fat content. Consumers also noted that people who wish to maintain or lose body weight should limit their nut intake. Some recalled past weight gain that they believed their nut intake had contributed to (Table 4).

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Stakeholder perspective

Stakeholders shared similar perceptions to consumers regarding the importance of portioning. It was perceived that the current recommendation of 30 grams of nuts per day would not cause weight gain and may be included by those who wish to maintain their body weight. Reasons for not contributing to weight gain were that nuts help to regulate appetite and that not all of the fats within nuts are absorbed by the body. Nut consumption above the recommendation of 30 grams per day could cause some weight gain (Table 4). One key distinction in opinions was stakeholders' comments about the need to consider the whole diet, rather than focusing on one food. All reported that body weight is influenced by the overall diet, rather than a single food. The whole diet and lifestyle of an individual needed to be evaluated when considering the impact of nuts on body weight.

Theme 4: Nutrition labelling is confusing for consumers and needs to be transparent and positively framed, if used

Consumer perspective

Some consumers report checking NIPs for specific nutrients, though others stated that they do not look at the NIP. For those that use NIPs, the nutrients that would usually be checked included protein, fats, sugars, sodium, and energy. For FOP labels, consumers felt these were sometimes used as a marketing trick by the food manufacturer, rather than being a reliable source of nutrition information (Table 5). When asked about their preferences for metabolisable energy of nuts on nutrition labels, consumers liked both NIPs and FOPs if the information was clearly presented and positively framed (for example, the FOP statement "Your body absorbs only 80% of the energy from nuts!" was perceived to have a positive tone, as opposed to "Your body cannot absorb all of the energy from nuts!"). Most liked seeing the metabolisable energy (as opposed to Atwater energy) in NIPs, but preferred both values, with the label explicitly stating which was which. Some were confused by two energy values. For metabolisable energy presented in FOP labels, consumers liked FOP labels that were honest and trustworthy, with a positive tone. It was evident that displaying metabolisable energy on nutrition labels was supported if it was planned for *all* packaged food and beverage products, not just nuts. Consumers highlighted the importance of being clear and consistent among all food products to avoid confusion about either nuts or energy content. Following this, consumers believed that it may be confusing to display the metabolisable energy of nuts on labels, due to the complex concept and making nutrition labels more confusing to read. Consumers were informed that the metabolisable energy differs by nut type, and this was one concern for labelling. Further, displaying percentages in

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FOP labels was criticised because it meant that consumers would need to calculate the new energy value, and it was confusing whether the NIP had already taken the percentage reduction into account. Furthermore, some consumers stated that metabolisable energy labelling, whether via NIPs or FOPs, would not influence which product they chose nor how many nuts they consume. Consumers noted that metabolisable energy labelling may be more useful for other health-conscious people, rather than themselves.

Stakeholder perspective

Many stakeholders believed that consumers typically do not read NIPs and would be more likely to be influenced by a FOP label (Table 5). There were varied responses regarding whether consumers would prefer products that show the metabolisable energy of nuts. Some acknowledged that health- or weight-conscious consumers may be more attracted to products showing a lower energy content, but this would not be important for all consumers. Others believed that consumers would prefer products with more energy, especially considering the use and understanding of the term 'energy' rather than 'kilojoules'. Either way, showing metabolisable energy on labels was perceived to be more meaningful for consumers. Stakeholders agreed that nutrition information presented on labels needs to be clear and positively framed. Most thought that nutrition labels are a source of confusion for consumers, and emphasised the need to present simple messages that consumers will understand. However, like consumers, stakeholders were more supportive of presenting metabolisable energy on *all* food products, not nuts alone. Given the perception that nutrition labels are already confusing for consumers, stakeholders reported that consistency in energy labelling is key. Presenting nut metabolisable energy exclusively on nutrition labels was not entirely convincing, and other strategies were suggested. Stakeholders, including dietitians, food industry professionals, public health professionals, and nut growers, thought that dietitians could discuss nut metabolisable energy with consumers during consults, or that an education campaign (such as social media) might be more effective. Most were wary of the feasibility of changing nutrition labels and noted that it would be time-consuming and expensive. The complexity of metabolisable energy as a concept was also highlighted, given that it differs by both nut type and by person. Therefore, it was perceived that nutrition labelling may not be the best route to communicate the metabolisable energy of nuts.

Theme 5: Knowing nut metabolisable energy will have limited perceived impact on nut consumption and advice, and is dependent on the individual and product

Consumer perspective

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Consumers reported that metabolisable energy of nuts could be useful information for some people, even if participants personally would not be influenced by it. People who are conscious about their weight or health may be interested in metabolisable energy and, therefore, choose products that present a lower energy content. The consensus was that preferences for displaying metabolisable energy on nutrition labels is dependent on the individual, rather than for everybody (Table 6). In addition, preferences for displaying metabolisable energy differed by product type. Bags of plain nuts, which may contain one single nut type or several types, were perceived as suitable. For nut butters (where the metabolisable energy is higher than for whole nuts) and products that contain small amounts of nuts, such as a breakfast cereal, presenting the metabolisable energy was perceived to be less helpful. Consumers reported that metabolisable energy labelling could be useful for individual nuts (not multi-ingredient foods), but ideally, energy labelling should be consistent among all food and beverage products.

Stakeholder perspective

Again, it was agreed that the metabolisable energy of nuts may be helpful for some consumers, not all. Consumers who are health-conscious or interested in nutrition were perceived to be more likely to check labels and be influenced by a lower energy value. Stakeholders also believed that metabolisable energy might be more influential for consumers depending on the type of product. Different varieties of peanut butters (such as an extra crunchy butter, or a high protein butter with added nut flours) may benefit from a FOP label showing the metabolisable energy and encourage consumers to purchase. For multi-ingredient foods that contain few nuts, it would be less impactful (Table 6). Many did not believe that consumers would increase their nut intake because of metabolisable energy labelling or think that the recommended 30 grams per day should change. Few had concerns about metabolisable energy encouraging people to “over-eat” nuts (more than 30 grams) or increasing their intake of other energy-dense foods. Some reported that the lower metabolisable energy could be useful in promoting nut intake and dispelling the weight gain myth. They agreed that understanding the metabolisable energy of nuts may be useful to health-conscious consumers, but product type (such as whole nuts versus a multi-ingredient product) should be considered. Stakeholders reported that energy labelling must be consistent among all packaged products to prevent confusion.

Discussion

Our study has provided insights into consumer and stakeholder perceptions of energy labelling for nut products. Knowledge of nuts and perceptions around their healthfulness

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varied. Consuming excess amounts of nuts was perceived to contribute to weight gain; however, stakeholders emphasised the importance of the whole dietary pattern. Presenting the metabolisable energy of nuts on nutrition labels was confusing at times, and participants expressed a need for nutrition labels to be transparent, positively framed, and consistent across food groups. In addition, knowing the metabolisable energy of nuts has little perceived impact on nut intake and advice regarding consumption. Overall, these findings suggest that including the metabolisable energy of nuts in nutrition labels may not be a straightforward solution in resolving concerns regarding the impact of nut consumption on body weight, hence other strategies may be needed.

Many participants reported that a small handful of nuts daily is unlikely to contribute to weight gain. However, the importance of portion control was emphasised, with regular intake exceeding 30 grams perceived to increase body weight. The high fat and kilojoule content of nuts was a barrier to intake for consumers. Surveys conducted in New Zealand, the United States, and Australia have reported consumer concerns regarding the effect of nut consumption on body weight [11, 13, 14, 30]. These surveys did not specify a portion size of nuts when exploring perceptions relating to weight gain. In comparison, in the present study, consumers and stakeholders agree that nuts generally would not impact body weight, if eaten in the recommended 30-gram portion. However, due to the methods in our study, participants were able to expand on their answers and provide reasons why they felt this way, including the importance of not over-eating nuts, which may explain the differences between the previous surveys and our study. The impact of an individual's diet and lifestyle was also highlighted by stakeholders, overruling the impact of a single food on body weight.

Relevant nutrition information can be relayed to consumers through several methods, such as in nutrition consultations, public health messaging, and by nutrition labels on food packaging. Stakeholder participants in our study believed that consumers do not typically read NIPs but may instead be influenced by FOP labels. This contrasted with use reported by consumers, who stated checking NIPs on packaged products to review certain nutrient contents, such as sugar, sodium, or saturated fat. When comparing NIPs and FOP labels, consumers had a preference for NIPs and viewed FOP labels as a marketing trick. This finding aligns with previous research in Australia and New Zealand, which found FOP labels including claims were often viewed as untrustworthy, whereas NIPs were trusted by consumers [31]. Taken together with the results of our study, the findings suggest that displaying the metabolisable energy of nuts may be more effective when shown in the NIP as opposed to using FOP claims, in turn aligning with consumers' trust in nutrition information.

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Despite consumers generally preferring NIPs to communicate metabolisable energy, some liked the concept of using a FOP label alongside an updated NIP to gain attention. Stakeholders agreed that FOP labels could be enticing. A study from 2023 reported that FOP labels that use colour and clearly identify if a product is healthy were useful in assisting consumers to choose healthier options compared to more complex labels [32]. In our study, some participants viewed the hypothetical FOP labels as a warning or criticism of their body being unable to absorb energy, which dissuaded product choice. The interpretation of these hypothetical labels contributes to the preference for clear, positively framed labels, which may encourage consumers to purchase nuts and nut products, thereby supporting nut intake in line with dietary guidelines.

In addition to considering the individual consumer, the type of product was influential in participants' preferences for nut metabolisable energy labelling. Consumers and stakeholders agreed that displaying the metabolisable energy of nuts on packaged whole nuts would be appropriate. Since the hypothetical labels were specific to nuts, they were considered transparent and not misleading. However, most participants reported that showing the metabolisable energy on multi-ingredient products would be misleading and unhelpful. Consumers and stakeholders queried the metabolisable energy of other foods, and this explains their preference for nut metabolisable energy labelling for whole nuts only and not for multi-ingredient food products (where metabolisable energy of other ingredients is not known). The complexity of products appears to relate to preferences for nut metabolisable energy labelling, where the more complex a product (multi-ingredient foods or nut butters with added sugars and oils), the less appropriate it becomes to display metabolisable energy of nuts. This differs from another Australian study which found that consumers prefer FOP labels on complex, multi-ingredient products [33].

The complexity of metabolisable energy as a concept led some participants to reject nut metabolisable energy labelling as a potential strategy to increase nut intake. While participants reported an understanding of metabolisable energy, both groups believed that many consumers would be confused by the hypothetical labels. Hence, metabolisable energy is a complex concept and labelling may not offer a simple strategy for promoting or increasing nut intake. Consumers and stakeholders commented on the minimal difference between metabolisable energy and the current energy value, and did not perceive it to be substantial enough to influence purchasing choice, nor intake. However, in a recent secondary analysis of 2011-12 NNPAS dietary data, there was a significant difference of up to 77 kJ between estimations of energy intake coming from nut intake (11.8 grams) using

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Atwater factors and metabolisable energy [34]. While this was statistically significant, the clinical significance of the estimated energy intake from nuts using metabolisable energy must be considered for a 30-gram portion. In the current study, stakeholders believed that many consumers do not use nutrition labels and, as a result, this would not be an effective strategy to increase nut consumption. Furthermore, stakeholders reported that changing nutrition labels is unlikely to be feasible, since it is a time-consuming and complex process, and a consistent approach to labelling is required. For these reasons, nutrition labels may not be a straightforward approach, and other strategies should be considered to promote nut consumption.

There are several strengths of our study. A variety of perspectives were captured, including Australian nut consumers, nutrition experts, industry professionals, public health professionals, and nut growers. Focus groups and interviews produce data which contribute to a deeper understanding of perceptions compared to quantitative methods, such as a survey. However, some limitations also exist. Participants were recruited from an online survey and were mostly young, educated females, likely interested in either nuts or nutrition. Therefore, the findings of our study may not be generalisable to Australian consumers and stakeholders. While there was diversity in the stakeholder group in terms of profession, only one nut grower participated, and none of the stakeholders worked in food regulation. Further, the small number of public health, food industry, and nut grower participants did not allow for meaningful comparison between stakeholder types. Following data collection, member checking was not performed. Implementing both focus group and individual interview methods may have affected responses. For example, one-on-one interview participants did not have the opportunity to consider other perspectives and participate in group discussions. Additionally, some focus groups consisted of only two participants which may have limited discussion among participants. Finally, focus groups are subject to social desirability bias, where participants report “socially acceptable” responses which may not reflect their real-life behaviours or perceptions.

Conclusion

Perceptions of presenting nut metabolisable energy on nutrition labels were multi-layered, suggesting displaying these values may not be a straightforward solution to resolving concerns regarding the impact of nut consumption on body weight. Of note, consistency in nutrition labelling across products is desired, and if using labels to communicate nut metabolisable energy, they should be clear and positively framed. Therefore, randomised controlled trials examining the impact of different labelling elements, and different nut types

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and nut-containing products are needed to investigate the precise impact of displaying metabolisable energy on consumer food choice and nut intake. Moreover, changing the macronutrient contents (such as fat content) in NIPs to reflect metabolisable energy may be explored in future studies.

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Tables

Table 1: Demographic characteristics of participants (focus group, n = 11; key informant interview, n = 9).

Participant demographics	**Consumers * (n (%))**	**Stakeholders † (n (%))**	**Total (n (%))**
Gender ‡ §			
Male/man	**4** (50.0)	**1** (8.3)	**5** (25.0)
Female/woman	**4** (50.0)	**11** (91.7)	**15** (75.0)
Non-binary	**0** (0.0)	**0** (0.0)	**0** (0.0)
Prefer to self-describe	**0** (0.0)	**0** (0.0)	**0** (0.0)
Age, years ¶			
18-25	**1** (12.5)	**3** (25.0)	**4** (20.0)
26-35	**4** (50.0)	**3** (25.0)	**7** (35.0)
36-45	**1** (12.5)	**4** (33.3)	**5** (25.0)
46-55	**0** (0.0)	**2** (16.7)	**2** (10.0)
56-65	**2** (25.0)	**0** (0.0)	**2** (10.0)
65 and older	**0** (0.0)	**0** (0.0)	**0** (0.0)
Professional category **			
Consumer	**8** (100.0)	NA	**8** (40.0)
Nutrition/dietetics	NA	**7** (58.3)	**7** (35.0)
Public health	NA	**2** (16.7)	**2** (10.0)
Food industry	NA	**2** (16.7)	**2** (10.0)
Food regulation	NA	**0** (0.0)	**0** (0.0)
Nut growing	NA	**1** (8.3)	**1** (5.0)
Highest level of education			
Partially completed high school	**0** (0.0)	**0** (0.0)	**0** (0.0)
Completed high school/Year 12	**0** (0.0)	**0** (0.0)	**0** (0.0)
Certificate or Diploma	**1** (12.5)	**0** (0.0)	**1** (5.0)
Bachelor's degree	**7** (87.5)	**3** (25.0)	**10** (50.0)
Master's degree	**0** (0.0)	**7** (58.3)	**7** (35.0)
PhD/doctoral degree	**0** (0.0)	**2** (16.7)	**2** (10.0)
Prefer not to say	**0** (0.0)	**0** (0.0)	**0** (0.0)

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Employment status ††			
Employed, working full-time	**3** (37.5)	**5** (41.7)	**8** (40.0)
Employed, working part-time	**0** (0.0)	**5** (41.7)	**5** (25.0)
Employed, casual	**1** (12.5)	**2** (16.7)	**3** (15.0)
Not employed, currently looking for work	**1** (12.5)	**0** (0.0)	**1** (5.0)
Not employed	**0** (0.0)	**0** (0.0)	**0** (0.0)
Student	**2** (25.0)	**4** (33.3)	**6** (30.0)
Retired	**1** (12.5)	**0** (0.0)	**1** (5.0)
Unable to work	**1** (12.5)	**0** (0.0)	**1** (5.0)
Prefer not to say	**0** (0.0)	**0** (0.0)	**0** (0.0)
Geographical area (living)			
Major urban (population ≥100,000)	**4** (50.0)	**8** (66.7)	**12** (60.0)
Other urban (population 1,000 to 99,999)	**3** (37.5)	**3** (25.0)	**6** (30.0)
Rural (population <1,000)	**1** (12.5)	**1** (8.3)	**2** (10.0)

NA, not applicable.

* n=8 consumer participants across two focus groups and one interview.

† n=12 stakeholder participants across two focus groups and eight interviews.

‡ At the time of demographic questionnaire development, gender question was phrased "What is your gender?" and options were 'Male', 'Female', 'Non-binary', and 'I prefer to self-describe (please specify)'. We acknowledge that 'male' and 'female' are not terminology used to describe gender and research in health sciences is evolving to recognise correct terminology.

§ Gender abbreviated for deidentified participant labels, e.g. male/man abbreviated to 'M'.

¶ Age range abbreviated for deidentified participant labels, e.g. 18-25 years abbreviated to '1825'.

** Participant category abbreviated for deidentified labels: 'Consumer' abbreviated to 'CONS', 'Nutrition/dietetics' abbreviated to 'DIET', 'Public health' abbreviated to 'PH', 'Food industry' abbreviated to 'IND', 'Food regulation' not abbreviated due to lack of participants, 'Nut growing' abbreviated to 'NUTG'.

†† Participants were instructed to select all options that apply for employment status.

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Table 2: Theme 1: Knowledge of nuts varies among consumers and stakeholders, and nuts are perceived to be both healthy and unhealthy.

Subtheme	Respondent	Exemplar Quotes
Knowledge and confusion	Consumer	"Things like almonds and is pistachio a kind of nut?" (CONS1825F1) "I know they have a high caloric value." (CONS2635M2)
	Stakeholder	"Nuts can contribute to a healthy diet by adding vitamin E, by adding fibre, by bringing protein, by bringing some very good fatty acids." (DIET3645F1) "There's that fat phobia, nuts are full of fat, nuts are not healthy, there's too many calories." (IND2635F1)
Nuts can be viewed as healthy	Consumer	"I've been a little bit more conscious that they can be nutritious, but in limited amounts." (CONS5665F1) "There's good fats and I know a lot of them are found in nuts." (CONS2635M2)
	Stakeholder	"I'm aware of the research that's showing that, you know, consuming nuts daily is associated with a reduced risk of, you know, your chronic diseases as well." (IND3645F1) "Nuts have protein and fibre, that's really nice and filling so I think it's a good tool if I was to suggest having 30 grams of nuts." (DIET1825F1)
Nuts and butters can be unhealthy	Consumer	"I think almonds are probably the exception that when you talk about health foods." (CONS3645F1) "Peanut butter from the organic wholefood grocer. And it was that they would take the peanuts and put it through the machine and it would come out at the bottom and go into a jar and nothing was added." (CONS5665M1)
	Stakeholder	"I think nuts that aren't covered in oil and salt are extremely healthy." (PH4655F1) "Peanut butter might have added fats, sugars, salt, that sort of thing." (DIET2635F2)

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Definitions of serve size	Consumer	“I'd go with like a small handful.” (CONS3645F1) “Probably a handful on each occasion.” (CONS2635M3)
	Stakeholder	“30 grams, I think is a serve for most nuts.” (IND2635F1) “I tend to say it's about a quarter cup so they can measure it out.” (DIET1825F1)
We don’t absorb all of the energy from nuts	Consumer	“I know that your body doesn't obviously process everything.” (CONS2635M1) “I don't know if this makes sense scientifically. But I think that because nuts are kind of solid. I feel like we might not be able to digest all of it, or take in all of you know, all of the content of the nuts.” (CONS1825F1)
	Stakeholder	“I don't know, I just know that less- all the fats in nuts are generally not absorbed because of the effects of fibre intake in nuts.” (DIET2635F2) “I had no idea that that was the case. I just thought your body would, yeah, absorb, yeah, all the energy from the food. So yeah, I was surprised.” (IND3645F1)

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Table 3: Theme 2: Nuts are versatile in the diet, yet nut intake is low.

Subtheme	Respondent	Exemplar Quotes
Variety of ways that consumers eat nuts	Consumer	"Sometimes I have a salad with like roasted pine nuts in it." (CONS2635M3) "Milk chocolate almond blocks from Aldi. Yeah, love those or the dark chocolate almonds." (CONS2635F1)
	Stakeholder	"Nuts can be incorporated in lots of different meals: salads, pasta, on your breakfast cereal, in your porridge, muffins, cakes, you know, you can put nuts in pretty much anything." (NUTG3645F1) "A really good sort of easy snack for consumers to have." (DIET2635F1)
Nuts are enticing (enabler)	Consumer	"It's easy to over-indulge, they're very more-ish because it's less than a mouthful to usually eat one nut." (CONS5665M1) "Sometimes they've got flavours added to them. But those ones I find if I eat those. It's, it's like once you start you can't stop." (CONS5665F1)
	Stakeholder	"People I think tend to over-consume, they don't have a good awareness of what one serve would be." (DIET1825F1) "When they get [eating], they just want to eat more and more." (PH3645F1)
Positive nut intake (consumers only)	Consumer	"I have it on my- my granola and stuff. So I think I have about that per day." (CONS2635F1) "Being like a good snack." (CONS2635M3)
Low nut or butter intake (reported and perceived)	Consumer	"Probably only about once a month." (CONS2635M3) "I just always think that, you know, it's a once in a while kind of food. It's not, you know, everyday food." (CONS1825F1)
	Stakeholder	"I don't think many people would eat 30 grams every day." (NUTG3645F1) "People, you know, like, eat a wide variety of foods, and they just

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		might not every single day, think that they have nuts." (IND3645F1)
Consumers face several barriers to intake	Consumer	"I just avoid them because I don't want to you know, blow my daily calorie budget on half a bag of nuts." (CONS2635M2) "I think the cost is a big reason why [I] maybe don't buy it [nuts] often. They're very expensive to get that raw nuts." (CONS2635F1)
	Stakeholder	"They are hesitant to consume nuts because they think it's gonna lead to weight gain." (DIET2635F1) "I think people are probably concerned about the cost of nuts. But I also feel like there was research recently that they're not actually like an expensive option." (IND2635F1)

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Table 4: Theme 3: Consumers perceive over-eating nuts will lead to weight gain, while stakeholders highlight the importance of considering the whole dietary pattern.

Subtheme	Respondent	Exemplar Quotes
30 grams per day (small portion) won't affect weight	Consumer	"With 30 grams per day, I don't think it will, you know, have any adverse effect on your body weight. Yeah, because yeah, I don't think 30 grams is a lot." (CONS1825F1) "I'd find it hard to see how they have an effect on body weight at all." (CONS2635M3)
	Stakeholder	"Nuts don't have an effect, in terms of that- they don't like- consumption of nuts isn't associated with an increase in body weight." (IND3645F1) "They can help you, when consumed in appropriate serving size... prevent weight gain, I guess to maintain weight." (DIET1825F2)
Eating large portions of nuts may cause weight gain	Consumer	"I think I could easily get fat if I eat too many nuts." (CONS5665M1) "I know that I certainly gained some weight with the amount that I was eating." (CONS5665F1)
	Stakeholder	"So for those who love to eat it a lot, yes, this could have effects on the body weight gain." (PH3645F1) "I also have to be mindful with a lot of clients who I see for weight loss about portion. So oftentimes, if I've got- seen a gentleman for the first time, who might be enjoying two cups of nuts while he sits and watches telly, we've had to talk about the, the calorie value of said two cups of nuts." (DIET3645F1)
Need to consider whole diet and lifestyle for body weight (stakeholders only)	Stakeholder	"As part of a whole broader, balanced dietary pattern." (IND2635F1) "Lifestyle approach even, thinking of exercise and hydration and sleep." (DIET3645F1)

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Table 5: Theme 4: Nutrition labelling is confusing for consumers and needs to be transparent and positively framed, if used.

Subtheme	Respondent	Exemplar Quotes
Consumers like and use NIPs (consumers only)	Consumer	"I typically just look at macros. So protein, fat, sugars…" (CONS2635M1) "Just have a quick look at the energy, skim to the sodium, maybe, maybe look at the fat." (CONS5665F1)
Perception that consumers would prefer metabolisable energy in FOPs (stakeholders only)	Stakeholder	"Many people would be interested in eating healthy food and would read the claims on the front, but wouldn't actually read or interpret the panel on the back." (NUTG3645F1) "For some consumers, they would be more tempted by option three simply because of that sort of that label. And I know like a lot of consumers will just read labels and assume that that, that equals to sort of better health outcomes, a lot of the time. As DIET2635F2 sort of said it's like that health halo." (DIET2635F1)
Like FOPs if clear and positively framed (consumers only)	Consumer	"If you wanted like a nice label to put for attention, I prefer the wording of option five, it's just a more positive tone to it." (CONS3645F1) "Option five says your body absorbs only 80% of the energy, it's non-judgmental. So it doesn't sound like they're criticizing my body." (CONS5665M1)
Believe some consumers want less kJ (stakeholders only)	Stakeholder	"They might compare the energy density and go for a less energy dense one." (DIET1825F2) "If people are conscious of calories and weight control, and things like that, I think option two." (IND3645F1)
More energy is good (stakeholders only)	Stakeholder	"Why even eat nuts then if I cannot absorb all the energy? Because I need energy? Because I have two children. Why would I pick non energetic food." (DIET3645F1) "And then I believe that when you eat this, should give you the normal required energy for the days- for the morning, for that meal." (PH3645F1)

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Nutrition messages need to be clear and positive	Consumer	"I'd go option three. Because it shows what's like, looks like it's showing exactly how much energy is in the nuts, but then how many, how much you can actually absorb." (CONS2635M1) "The colours and the tick, the sort of positive affirmation mode of that." (CONS5665M1)
	Stakeholder	"Option two I think would be very straightforward, if you eat this amount, this is what you are going to receive, energy-wise." (DIET1825M1) "And if it's just to reassure people that they can eat nuts without worrying, then make that message loud and clear." (PH4655F1)
Metabolisable energy labelling for all foods (consistency)	Consumer	"Because if it is just the nuts, then it would be misleading, because the assumption would be that other ingredients actually also have different absorption values. So it should be the product as a total, not just on the nuts." (CONS2635M2) "Yeah, it should be like that for every food would be nice." (CONS2635M2)
	Stakeholder	"I don't know if adding metabolis- metabolisable energy in terms of nutritional information panels, is feasible, because then a whole bunch of other foods might want to have... that on the claim." (DIET2635F2) "Yes, should be for all foods, not [just] nuts." (PH3645F1)
Metabolisable energy labelling may be confusing (consumers only)	Consumer	"If it's some mix of nuts, I'm not too sure how, yeah, how it's going to be presented." (CONS1825F1) "Is that 10%, like less of the 678? Or is that already been taken into account? It's like a little bit confusing." (CONS2635M1)
Metabolisable energy labelling may not be the	Stakeholder	"It's different for each person, it's different for each nuts, I think we'd have to be careful about giving such a percentage, specific percentage." (DIET3645F1)

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best route (stakeholders only)		“In terms of feasibility, knowing what FSANZ is like, I would say, not feasible, because it's a very long, arduous process. It's not easy to change anything to do with food labelling, is my understanding. And it all takes a very long time.” (IND2635F1)

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Table 6: Theme 5: Knowing nut metabolisable energy will have limited perceived impact on nut consumption and advice.

Subtheme	Respondent	Exemplar Quotes
Metabolisable energy could be impactful, depending on person and product	Consumer	"I also do think that your labels like this probably matters more to people who do sports or people who really need to watch their diet. But yeah, I guess if you just consume it casually, I guess, you know, it makes less sense. Or, you know, it's less important." (CONS1825F1) "I don't think that would stop or make me want to buy that product more. I'd still be buying my almond choccy regardless." (CONS2635F1)
	Stakeholder	"Yes, I think there's a different market for peanut butter than whole nuts. Like when you go to the peanut butter section in the supermarket, there's so many different ones and like all the high protein ones with the extra nut flours... I think people would be influenced more by, like front of label- labels, like option three... for the nut butter." (DIET1825F2) "In a mixed food... You know, like a breakfast cereal, for example, the percentage of nuts might be quite low. So again, I think it's probably not going to be that significant that you're not absorbing all the energy from the nuts 'cause it's going to be quite small." (IND3645F1)
Metabolisable energy is not different enough to change 30-gram serve, advice, intake, or consumer choice	Consumer	"I'd look at that and go 580 and 590. I go... Well, That's stupid. I'm just going back to option one." (CONS2635M3) "Because I'm not in survival mode. It's not like I'm on Alone Australia, and I need to get 100% of the energy out of every morsel that I eat. So 10 percent's not really significant. I can have a really big tablespoon or a not so big tablespoon, it's probably gonna make the same difference to what I'm consuming- or what I'm absorbing." (CONS5665M1)
	Stakeholder	"Does it impact how I would tell someone, it's good to have 30 grams of nuts every day? No, I think that's- that would stay the

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		same whether or not all the fat is fully metabolisable or not." (DIET2635F2) "I think it would be pretty negligible... if it's only, well per serving, 10 kilojoules less, I don't think people would be that [hawkeye] about it." (DIET1825M1)
Metabolisable energy may be used to promote nut intake (stakeholders only)	Stakeholder	"It might help with promoting that message that even though they have a high fat content, they're not likely to, to make you gain a whole lot of weight." (NUTG3645F1) "That's something that us as health professionals can sort of work off in terms of like, our recommendations to clients or like, just our advice in general." (DIET2635F1)

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