Knowledge and attitudes towards Vitamin D food fortification

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<th>Nutrition and Food Science</th>
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<tr>
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Abstract
Purpose: Vitamin D deficiency is a well-recognised public health problem within the UK, with specific population groups more vulnerable to deficiency. Two pilot studies were used to explore awareness of vitamin D deficiency and attitudes towards food fortification.

Methodology: A survey of 120 participants from five at risk groups (South Asians, Blacks, Middle Eastern, Far Eastern and Caucasian older adults over 65 years) plus a group of British Caucasians who do not avoid sun exposure, explored awareness of vitamin D, sun exposure knowledge and behaviour, and attitudes towards food fortification. The latter group was included to provide a comparison group who were at a reduced risk of deficiency. Chi-square ($\chi^2$) was used to test associations between categorical variables and the study groups. The second study utilized three focus groups and two interviews, conducted on young South Asian females and examined knowledge and awareness of vitamin D and vitamin D fortified foods.

Findings: A lack of knowledge and misconceptions were highlighted by both studies in relation to at risk factors including sunlight exposure ($p = 0.037$), dietary intakes ($p = 0.0174$), and darker skin pigmentation ($p = 0.023$), sources of vitamin D and the health benefits associated with optimal consumption. Attitudes to mandatory fortification of some foods varied significantly ($p = 0.004$) between the groups with acceptance rates for Blacks (68%), those over 65 years (50%), Middle Eastern (67%) and Far Eastern (73%), whereas the control (71%) showed no acceptance, and South Asians gave a mixed response (48% No). Focus group findings highlighted positive views towards fortification although this was less for mandatory as opposed to voluntary fortification. Both pilot studies highlight the need for more research into this area, in order to create more effective public health policies.
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Originality/value: The research presents novel insights into a topical area where there is limited research.

Key words: vitamin D deficiency, knowledge, consumer attitudes, fortification, at risk groups

Classification: research paper
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Introduction

Vitamin D deficiency has gained great interest recently both in the UK and further afield (Palacios and Gonzalez, 2014), with a number of new health conditions now being associated with deficiency, which is on the increase globally (Borradale and Kimlin, 2009, Chowdhury et al., 2014, Holick, 2017). The UK, and countries of similar latitude, are particularly susceptible to vitamin D deficiency due to inadequate UVB-sunlight exposure from October to April.

In addition to latitude, additional factors increase the risk of developing deficiency including; aging, obesity, sunscreen use, cultural practices which cover the skin and darker skin pigmentation, with individuals with higher amounts of melanin requiring longer sun exposure to synthesise vitamin D (Battault et al., 2013, McAree et al., 2013, Reeder et al., 2012). This is exacerbated when those with darker pigmentation migrate to northern latitudes such as northern Europe, including the UK, making them more prone to vitamin D deficiency (Ashwell et al., 2010, Kift et al., 2013, Meyer et al., 2008, Pearce and Cheetham, 2010).

As minimal vitamin D is synthesised during winter, a greater dependence on dietary sources occurs (Cashman, 2007, Ashwell et al., 2010). UK dietary recommendations have been reviewed and updated by the Scientific Advisory Committee on Nutrition (SACN, 2016) calling for a Reference Nutrient Intake of 10µg/ day for the vitamin for the first time, including the elderly, pregnant and lactating women and those from ethnic groups who have pigmented skin, where again 10µg/day is recommended. However, it has been suggested the UK South Asian population are unaware of these recommendations (Farrar et al., 2011).

In the UK dietary sources include oily fish, egg yolk, and meat (Ashwell et al., 2010). However, these foods are infrequently consumed (Cashman, 2012). Black et al. (2012) propose a typical Western-style diet is currently unable to provide 10 – 20 µg of vitamin D/day, with evidence from the National Diet and Nutrition Surveys supporting this, with
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typical mean daily intakes being considerably lower than the Reference Nutrient Intake for both children and the elderly (Bates et al., 2012).

There have been calls nationally among certain vitamin D researchers to introduce a more comprehensive fortification of food with vitamin D policy in the UK where very few foods are currently fortified. This position is in stark contrast to the fortification practices in the USA and Canada where fortified foods are the main dietary source of vitamin D (Calvo and Whiting, 2006). Furthermore, the introduction of the fortification of food with vitamin D of all liquid dairy products and fat spreads in Finland in the mid 2000’s has resulted in clear benefits to population vitamin D status (Boucher, 2012, Jääskeläinen et al., 2017), highlighting the potential for food fortification in addressing vitamin D deficiency.

Dietary staples such as milk, dairy products, juice, cereals and bread are typically fortified with vitamin D (Kiely and Black, 2012). However, these will only target selected groups of the population and do not take into account variations in dietary habits, which should be considered (Black et al., 2012) especially for at risk groups who may have culturally diverse dietary habits.

A review of fortification policy is becoming increasingly pertinent in light of the SACN review. However, prior to any changes in food policy it is imperative to consider consumers understanding of vitamin D and fortified foods, especially those most at risk of deficiency, so as to develop effective public health policies.

There is very little information available regarding consumers’ knowledge and awareness of vitamin D and its dietary sources, especially in at risk groups of the population (Kung and Lee, 2006). This project therefore describes two pilot studies that investigate awareness of dietary vitamin D and attitudes towards food fortification among at risk groups living within Newcastle-upon-Tyne, an area of the UK at increased risk of deficiency due to its latitude.
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Methodology

Introduction

Two pilot studies were used; the first to establish awareness and knowledge of vitamin D by means of a survey in five at risk groups of the population, and the second providing a more in-depth exploration of attitudes towards the fortification of food with vitamin D by means of both focus groups and interviews with one specific at-risk population group, so as to provide insights into barriers and drivers of acceptance of vitamin D fortified foods. Studies were conducted a year apart, with no individuals participating in both studies. Results of both studies are then discussed together in the discussion so as to provide greater insight into vitamin D awareness.

Study 1: Quantitative Pilot Study

The survey was adapted from a pre-existing questionnaire (Alemu and Varnam, 2012), being modified to meet the research aims of this study. Questions were either updated or removed and replaced by additional questions on sunshine exposure and dietary habits, ethnicity, UK residency, vitamin D levels, and mandatory food fortification. Occupational categories were deemed more appropriate than questions on income, and terms defined in a similar study by Kung and Lee (2006) were used. Ethnicity categorisation was taken from the Economic and Social Data Service Government publication (Afkhami, 2012), with the exception of the Arabic/Middle Eastern category, that was added to reflect the inclusion of this target group.

The resulting survey consisted of 41 questions divided into four sections: demographics, vitamin D awareness and knowledge, sun exposure habits and dietary intake, and attitudes towards food fortification. Food groups were in the form of a short semi-quantitative Food Frequency Questionnaire (FFQ).

The study took place in Spring 2013. Participants were recruited from groups identified as being at risk of deficiency included: older adults aged over 65 years, South Asians, Blacks,
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Middle Eastern, Far Eastern, and a group of British Caucasians who do not avoid sun exposure. This latter group was included so as to provide a comparison to a group who were at a reduced risk of deficiency. Research was conducted in line with the university ethics policy (approval obtained October 2012 – see supplementary material).

A screening questionnaire consisting of seven questions was also used to assign a target group to each participant. All surveys were completed on paper hard copies. The majority of surveys were completed face-to-face with a researcher with only a few exceptions, whereby surveys were taken home by participants, and once completed surveys were either posted back to the University or collected at a later date from community group locations by a researcher. As the survey was only available in English assistance was offered in reading the questions. This was provided by English speaking community group members in the presence of a researcher so as to enable any questions to be asked.

Study 2: Qualitative Pilot Study

Qualitative methods were chosen for the second pilot study due to their ability to provide in-depth information and elicit underlying reasoning from participants, something that is not always possible during quantitative research (Threlfall, 1999). Both focus groups and interviews were used.

Careful consideration was paid to controllable aspects known to contribute towards focus group best practice, including focus group environment, the research team and participant recruitment. Both focus groups and interviews were held on campus in Spring 2014, and were recorded to enable transcription and subsequent analysis. A moderator and an assistant researcher were also present to help record participant body language and facial expression, to help inform the face validity of the results.
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Although debate still exists as to the best composition of focus groups, pre-existing friendship groups were used in this research to make use of the “naturalistic exchanges” between participants, and to encourage the disclosure of information.

Convenience, purposeful sampling was used to ensure that young South-Asian females were recruited for the study. Participation was restricted to those who could speak English, but there was no restriction on how long participants had resided in the UK. Awareness of the focus groups was raised at three locations around campus known to be frequented by international students, with students being invited to leave their contact details with researchers so that they could be provided with more information.

A semi-structured approach was taken, with a discussion guide being created from a detailed literature review in relations to the aims of the investigation. Questions were asked to establish participants’ baseline awareness and attitudes towards vitamin D, sources and health benefits, with further information provided about the health consequences of deficiency after initial discussions were held.

Due to participant non-attendance at focus groups, two individual interviews were also conducted using the same discussion guide as the focus groups. These provided a further opportunity to explore participants’ attitudes and knowledge, whilst not being affected by group bias, a potential risk in focus groups (Threlfall, 1999).

Data Analysis

SPSS version 19.0 (SPSS, 2010) was used for analysis. Chi-square ($\chi^2$) tests were used to examine associations between the study groups and the questions at the 5% significance level ($p <0.05$). Analysis of the awareness of the health benefits of vitamin D and preference for voluntarily fortified foods included the study groups as a total group ($n=120$). Therefore, no
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\( \chi^2 \) associations were made, however the frequency (and percentage) of the stated health benefits are shown.

A thematic approach was taken to data analysis, which enabled key themes to be identified and reported across data sets (Braun and Clarke, 2006) relevant to the aims of the study. After having familiarised themselves with the transcripts researcher notes, codes were ascribed to describe meaning of the data. These codes were then organised into themes that helped to explain the codes, in relation to the research aims.

Results

Study 1

Demographics

Table 1 summarises participant demographic information in addition to their knowledge of sunlight as a source of vitamin D. 120 completed surveys were obtained, by significantly more females (53%) than males (45%; \( p = 0.001 \)), with their being a significant differences in age distribution across groups \( (p = <0.001) \), period of residence in the UK \( (p = <0.001) \), occupation \( (p < 0.001) \), and highest level of education \( (p < 0.001) \) across groups. A similar number of responses were obtained across at risk and the control groups as highlighted in table 1.

Health benefits of vitamin D

Table 2 summarises awareness of the health benefits associated with vitamin D among the whole group \( (n=120) \), with \( \chi^2 \) analysis was not performed on this question due to the inclusion of the whole group. Bone health was the most common benefit mentioned, with 37% of respondents stated that vitamin D is beneficial for this, with the next most frequent categories being healthy skin (18%) and general health/fitness (11%). More specific health
Knowledge of vitamin D conditions, such as those listed in Table 2, were spontaneously associated by no more than 8% of respondents each.

Risk Factors for vitamin D deficiency

The belief that inadequate sun exposure is a risk factor for vitamin D deficiency, was significantly different between the groups ($p = 0.037$). South Asians were most likely to know that inadequate sun exposure is a risk factor with 84% believing that it increased the risk of deficiency, followed by the British Caucasian group (71%). However, just 45% of those over 65 years believed it increases risk whilst a further 40% did not know. This was also evident among Black respondents, whereby 50% said it increases risk and 32% did not know.

Figure 1 highlights that awareness of natural darker skin pigmentation as a risk factor for vitamin D deficiency, was significantly different across groups ($p = 0.023$). Interestingly, almost half of South Asians (40%) thought having natural darker skin pigmentation does not affect the risk of vitamin D deficiency, whilst half of the Black respondents did not know. A similar response was also found among Middle Eastern and British Caucasian respondents whereby just over half (52%) said they did not know.

Awareness of inadequate dietary consumption as a risk factor for vitamin D deficiency, was not significantly different across groups ($p = 0.174$). The majority of the South Asian and British Caucasian groups believed it increases risk (80% and 71%, respectively). However, there was much variation across the Middle Eastern group, in that 48% of respondents responding that it increases yet 43% did not know.

Although sun cream use was notable across the groups, over 40% of respondents in each group, except for Far Eastern respondents (only 27%), did not know that using sun cream is a
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risk factor for deficiency. Few respondents in all groups said it increases risk, in the range of 2-3 respondents (data not shown).

Those over 65 years had the highest ‘don’t know’ response as to whether inadequate sun exposure is a risk factor for vitamin D deficiency; with 40% who did not know whilst just 45% said it increases risk. Likewise, 55% did not know that using sun cream is a risk factor for deficiency thereby suggesting that those over 65 years have limited awareness of vitamin D.

Awareness and preference of fortification of foods with vitamin D

Over 60% respondents in each at risk group, in particular 90% of Black respondents, were unaware of foods currently fortified with vitamin D. Interestingly the majority of the British Caucasian group (71%), as a group not as at-risk of deficiency, were aware of such foods. In terms of preferences of fortified products, breakfast cereals were most preferred (64%), followed by cow’s milk (58%), fortified fruit juice (55%) and margarine and spreads (47%). Mandatory fortification of some foods would be accepted by Blacks (68%), those over 65 years (50%), Middle Eastern respondents (67%), and the Far Eastern respondents (73%). However, the Caucasian British group (71% no) did not show acceptance whilst South Asians gave a mixed response (48% said yes, and 52% said no). This was significantly different between the groups (p=0.004).

Study 2

In total three focus groups and two individual interviews were conducted on 16 South-Asian females all under the age of 25, with nine students from South-Asian countries having lived in the UK for less than a year.

General unawareness was a key theme to emerge across all focus groups and interviews in relation to dietary sources and vitamin D’s role in health, with the sun being cited as a source...
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of vitamin D by the majority of participants. However, the long-known association with bone health was less frequently identified by participants, although still the most frequently mentioned health benefit. Participants were therefore shocked by some of the consequences of vitamin D deficiency presented to them during the focus groups.

A number of participants, specifically those who had lived in the UK for less than a year, were unable to identify a source of vitamin D, with others, again who were not long-term UK residents, being unaware that vitamin D could be obtained from dietary sources, despite correctly identifying the sun as the main source of vitamin D. This general theme of unawareness also extended to participants’ knowledge of at risk groups from vitamin D deficiency, with participants admitting to not knowing who would be most at risk. Interestingly, a small number of participants did cite pale skinned persons as being more at risk of deficiency, when in fact the opposite is true.

For those who indicated some previous awareness of vitamin D the media was cited as the main source, including recent advertising appeals;

“I have heard about vitamin D because of yoghurt advert on T.V.” Focus Group 1, Participant 4

As well as a general unawareness of vitamin D, misconceptions also arose in relation to dietary sources of vitamin D and the health benefits from achieving and obtaining adequate vitamin D levels. This was highlighted by one participant citing that the main purpose of vitamin D within the body was to induce a sun tan.

Participants were also unaware as to the key concepts associated with fortification with “extra supplements” being the closest suggestions made by participants as to what fortification entailed, with the majority being unsure, despite their awareness of fortified
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foods adverts on television, indicating that they may not be entirely aware of why products
are fortified.

In light of participants lack of knowledge of vitamin D, a definition of fortification was
provided in focus groups and interviews to enable participants’ opinions on the subject to be
obtained. Subsequently views on fortification were categorised as a theme, in relation to both
voluntary and mandatory fortification, with the former being received in a positive light and
raising little concern;

“If it is good for people’s health then it is fine” Focus Group 1, Participant 4

“Prevention is better than cure” Focus Group 2, Participant 5

The naturalness of fortification was raised as a concern, indicating a need to take this into
consideration and use appropriate communications when marketing fortified foods;

“I think if they want to fortify foods with it, then they should probably put the nutrients in
foods that intrinsically have similar properties that could contain such vitamins, because it
wouldn’t make sense if you put it in something that is not used to such kind of nutrition, it
may cause some kind of imbalance” Focus Group 1, Participant 2

“I would worry that it not natural and so, against nature and could be bad for you” Focus
Group 2, Participant 7

Despite the general positive views towards voluntary fortification, mandatory fortification of
foods with vitamin D received more of a mixed response with concerns being raised by
individuals in relation to consumer choice and toxicity, the latter of which being raised in
every focus group and interview indicating that it is not an isolated concern.

Despite the concerns raised in relation to fortification, most participants would prefer to
consume fortified food products rather than take supplements, with the view that supplements
were unnatural, inconvenient and seemed far too medical.
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Participants were asked to suggest specific foods that they would like to see fortified with a range of responses given including bread, milk and dairy products, vegetables, cereals, chocolate, eggs and water. The range reflects their personal dietary preferences, with the majority of participants reported consuming a diet that is a mixture of the two cultures, reflecting either a UK upbringing or current residential status in the UK, with selected food products being mentioned due to participants’ beliefs that they would benefit the population as a whole e.g. bread and milk.

Discussion

This paper presents two pilot studies of the awareness of vitamin D and attitudes towards food fortification in at risk groups in the North East of England. Consideration of food fortification with vitamin D in order to improve vitamin D intakes at a population level have been proposed in the literature (Lamberg-Allardt, 2006, Kiely and Black, 2012, O'Mahony et al., 2011, Calvo and Whiting, 2006). Therefore, this study provides an insight into specific at risk consumers’ attitudes and acceptance towards foods fortified with vitamin D as well as their awareness of vitamin D. This is particularly important research for research nutritionists, food manufacturers and scientists involved in setting public health nutrition policy.

The findings of this research support those in a study by Alemu and Varnam (2012), whereby minimal awareness was evident among men and older adults and they suggest age as an important factor in determining level of awareness. Similarly, Kung and Lee (2006) found a lack of awareness among older Chinese women, with awareness appearing to decrease in age. Farrar et al., (2011) indicated that there is a lack of data on sunshine exposure habits of UK South Asians and they suggest that South Asians may adopt less sun-seeking behaviours. Although the majority of participants across all groups knew that sunlight was a source of vitamin D, most were unaware of the time required to obtain sufficient vitamin D from
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sunlight exposure. This lack of awareness, and avoidance of sun-seeking behaviours amongst
at-risk groups, indicates a need for greater communication of safe sun exposure information.
School was the major source of information for all the groups, bar the British Caucasians and
those over 65 years (data not shown), with the media also being cited as a key source of
information, especially for focus group participants where the media was the main source of
information, including recent adverts of fortified foods. These main sources of information
are similar to previous studies (Alemu and Varnam, 2012). This suggests school and media
have an important role in increasing awareness of vitamin D and sun exposure, and could be
key mediums for dissemination information for increasing vitamin D intakes.

Less than half of participants across all groups identified bone health as a benefit of optimum
vitamin D, which was reflected in the qualitative findings, with considerably fewer
participants being able to identify other benefits. This reflects previous research in Saudi
Arabia, where Christie and Mason (2011) found awareness of vitamin D benefits restricted to
musculoskeletal health. Although other health benefits were commonly reported in the
present study were healthy skin and general health/fitness, yet few participants did not know
that vitamin D was beneficial, again as evident in previous research (Bonevski et al., 2013).
This indicates that people are aware that vitamins in general are beneficial yet many are
unaware of the specific benefits associated with vitamins, in this case vitamin D. Given the
association of vitamin D with an increasing number of health conditions, conveying the
health benefits of ensuring vitamin D sufficiency to increase awareness would seem of
critical importance, given such limited awareness currently exists.

Further to the results indicating a lack of awareness of the benefits associated with vitamin D,
the findings from both studies indicate a lack of awareness, or inability of participants to
correctly identify at-risk factors for vitamin D deficiency, including factors that would put
themselves at risk, such as having a naturally darker skin pigmentation. This was particularly
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the case in the qualitative research for those who had lived in the UK for less than a year, who had particularly limited awareness. Given that research has indicated several cases of vitamin D deficiency in the UK in at-risk groups (Moy et al., 2012), ensuring that these groups are reached with communications to enable themselves to identify as being at risk is essential. Otherwise, at-risk individuals may not view fortified products, or supplements, as relevant or necessary for themselves. This was exemplified in the results of the survey, with the majority in all at risk groups being unaware of foods currently fortified with vitamin D. However, the majority of the British Caucasian group (71%), those at a reduced risk of deficiency, were aware of such foods fortified with vitamin D. This indicates that current fortified food products are not currently targeting those at risk of deficiency or are not communicating effectively that they have been fortified. Given the potential for fortified foods to increase vitamin D levels (Jääskeläinen et al., 2017), the identification of appropriate foods to fortify for at risk groups is essential, and future research should look to explore this in more depth, with more representative samples.

Results from both studies indicated no preference for products to be voluntarily fortified with vitamin D, with there also being no consensus over the influence of mandatory fortification in purchasing staple products such cow’s milk or bread, other than for the British Caucasian group, who were not in favour.

The lack of preference for fortification of certain products, and for mandatory fortification in general, may be partially explained by concerns raised during the qualitative research, in relation to toxicity, consumer choice and naturalness. This reflects findings by Tedstone et al., (2008) who found mandatory fortification of folic acid was generally accepted amongst participants, although concerns regarding consumer safety and choice were raised. This highlights a need for effective communication in relation to the safety of fortified products,
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and clear labelling, especially for voluntary fortification, to ensure consumer freedom of choice is maintained.

Recommendations
Further research could include other groups at risk of deficiency such as pregnant women, obese individuals, and care providers for those in institutionalised care. It would also be interesting to increase the sample size so as to make inferences about whether a particular factor influences the level of vitamin D awareness among these different at risk groups, and to conduct more research into which foods would be the most appropriate and acceptable to fortify to target those most at risk of vitamin D deficiency. Future research should also look to establish the effect of conveying information on the health benefits of vitamin on willingness-to-purchase and preferences for fortified products.

Conclusion
Food fortification with vitamin D is a promising approach to increase vitamin D intake in countries and groups susceptible to vitamin D deficiency. Both these pilot studies identified a distinct lack of awareness of vitamin D and fortified foods among at risk groups of the UK population, although favourable attitudes towards fortification, particularly voluntary fortification, were displayed. Further research, on a larger scale, is needed in this area to enable a better understanding of the knowledge and attitudes of vitamin D and fortified foods among these at risk groups so that the most effective public health policies can be introduced.

Research Considerations
Both studies are limited by small sample sizes, a result of the difficulties experienced whilst trying to recruit participants from the specific groups of the population within a limited time frame. Subsequently, future research should look to ensure larger, stratified samples to improve the results generalisability. In addition, years of residence in a country could be added to further explore any variations in attitudes and preferences this may bring. The
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sequence of questions could have been improved to reduce potential bias, in that questions on
awareness and knowledge precede that of behaviour and attitudes. Therefore, participants
may become more favourable towards fortification after answering questions on awareness
and knowledge of vitamin D, after realising they may not get adequate vitamin D themselves.
For the qualitative study a more representative sample of the South Asian population could
have been used, to encompass a wider range of ages and a mix of genders, thus enabling a
more representative view of the populations’ knowledge and attitudes to be obtained.
However, both pieces of research present novel studies, into an area where there is limited
research. The quantitative study design enabled a direct comparison between different
ethnicities and the control group, with the qualitative study enabling more in-depth
information to be obtained to further explore consumers’ knowledge and attitudes.

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Table 1: Demographic and sample size information for each group of survey participants

<table>
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<th>Question</th>
<th>South Asian (n=25)</th>
<th>Black (n=22)</th>
<th>Over 65 years (n=20)</th>
<th>Arabic and Middle East (n=21)</th>
<th>Far Eastern (n=11)</th>
<th>Control (n=21)</th>
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<tbody>
<tr>
<td>a.) Gender</td>
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<tr>
<td>Male</td>
<td>14 (54%)</td>
<td>16 (73%)</td>
<td>2 (10%)</td>
<td>12 (60%)</td>
<td>4 (36%)</td>
<td>6 (29%)</td>
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<tr>
<td>Female</td>
<td>10 (38%)*</td>
<td>6 (27%)</td>
<td>18 (90%)</td>
<td>8 (40%)</td>
<td>7 (36%)</td>
<td>15 (71%)</td>
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<td>*p = 0.001</td>
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<td>b.) Age group</td>
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<tr>
<td>18 – 34 years old</td>
<td>23 (88%)</td>
<td>10 (45%)</td>
<td>0 (0%)</td>
<td>17 (85%)</td>
<td>6 (55%)</td>
<td>7 (34%)</td>
</tr>
<tr>
<td>35 – 49 years old</td>
<td>2 (8%)</td>
<td>11 (50%)</td>
<td>0 (0%)</td>
<td>2 (10%)</td>
<td>4 (36%)</td>
<td>3 (14%)</td>
</tr>
<tr>
<td>50 – 64 years old</td>
<td>0 (0%)</td>
<td>1 (5%)</td>
<td>0 (0%)</td>
<td>1 (5%)</td>
<td>1 (9%)</td>
<td>11 (52%)</td>
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<tr>
<td>Over 65 years old</td>
<td>1 (4%)</td>
<td>0 (0%)</td>
<td>20 (100%)</td>
<td>0 (0%)</td>
<td>0 (0%)</td>
<td>0 (0%)</td>
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<tr>
<td>*p = &lt;0.001</td>
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<td>c.) How long have you been resident in the UK?</td>
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<tr>
<td>All my life</td>
<td>11 (42%)</td>
<td>2 (9%)</td>
<td>16 (80%)</td>
<td>2 (10%)</td>
<td>0 (0%)</td>
<td>18 (86%)</td>
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<tr>
<td>Less than a year</td>
<td>5 (19%)</td>
<td>2 (9%)</td>
<td>0 (0%)</td>
<td>4 (20%)</td>
<td>3 (27%)</td>
<td>0 (0%)</td>
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<tr>
<td>Between 1-3 years</td>
<td>4 (15%)</td>
<td>2 (9%)</td>
<td>0 (0%)</td>
<td>5 (25%)</td>
<td>0 (0%)</td>
<td>0 (0%)</td>
</tr>
<tr>
<td>Between 3-5 years</td>
<td>2 (8%)</td>
<td>3 (14%)</td>
<td>1 (5%)</td>
<td>4 (20%)</td>
<td>0 (0%)</td>
<td>0 (0%)</td>
</tr>
<tr>
<td>More than 5 years</td>
<td>3 (12%)*</td>
<td>12 (55%)*</td>
<td>1 (5%)*</td>
<td>5 (25%)</td>
<td>8 (73%)</td>
<td>3 (14%)</td>
</tr>
<tr>
<td>*p = &lt;0.001</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>e.) What is your highest qualification?</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>GCSE / GNVQ or equivalent</td>
<td>3 (11%)</td>
<td>3 (14%)</td>
<td>3 (15%)</td>
<td>1 (5%)</td>
<td>0 (0%)</td>
<td>5 (24%)</td>
</tr>
<tr>
<td>AS / A Level or equivalent</td>
<td>11 (42%)</td>
<td>1 (5%)</td>
<td>1 (5%)</td>
<td>1 (5%)</td>
<td>1 (9%)</td>
<td>1 (5%)</td>
</tr>
<tr>
<td>Diploma</td>
<td>0 (0%)</td>
<td>4 (18%)</td>
<td>2 (10%)</td>
<td>2 (10%)</td>
<td>1 (9%)</td>
<td>2 (10%)</td>
</tr>
<tr>
<td>Foundation Degree</td>
<td>0 (0%)</td>
<td>1 (5%)</td>
<td>0 (0%)</td>
<td>2 (10%)</td>
<td>2 (10%)</td>
<td>0 (0%)</td>
</tr>
<tr>
<td>Degree</td>
<td>7 (27%)</td>
<td>4 (18%)</td>
<td>3 (15%)</td>
<td>4 (20%)</td>
<td>4 (36%)</td>
<td>7 (33%)</td>
</tr>
<tr>
<td>Postgraduate Degree</td>
<td>3 (11%)</td>
<td>6 (27%)</td>
<td>0 (0%)</td>
<td>9 (45%)</td>
<td>2 (18%)</td>
<td>4 (19%)</td>
</tr>
<tr>
<td>Other professional qualification</td>
<td>0 (0%)</td>
<td>1 (5%)</td>
<td>4 (20%)</td>
<td>0 (0%)</td>
<td>0 (0%)</td>
<td>0 (0%)</td>
</tr>
<tr>
<td>Other qualification</td>
<td>1 (4%)*</td>
<td>1 (5%)*</td>
<td>1 (5%)*</td>
<td>1 (5%)</td>
<td>3 (27%)</td>
<td>0 (0%)*</td>
</tr>
<tr>
<td>*p = &lt;0.001</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Responses for some questions do not add up to 100% due to participants declining to provide this information.
GCSE - General Certificate of Secondary Education; GNVQ - General National Vocational Qualification; AS/A levels - Advanced Subsidiary/ Advanced level
Data across groups was compared with a Chi-Square test
### Table 2: Health benefits associated with vitamin D as listed by survey participants

<table>
<thead>
<tr>
<th>What health benefits do you associate with vitamin D?</th>
<th>Number participants citing the benefit (n=120)</th>
<th>Percentage of participants citing the benefit (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bone Health</td>
<td>44</td>
<td>37%</td>
</tr>
<tr>
<td>Healthy skin</td>
<td>21</td>
<td>18%</td>
</tr>
<tr>
<td>General health/fitness</td>
<td>13</td>
<td>11%</td>
</tr>
<tr>
<td>Mental health/cognition/improves mood</td>
<td>10</td>
<td>8%</td>
</tr>
<tr>
<td>Absorption of calcium</td>
<td>8</td>
<td>7%</td>
</tr>
<tr>
<td>Hair and nails</td>
<td>8</td>
<td>7%</td>
</tr>
<tr>
<td>Strong teeth</td>
<td>7</td>
<td>6%</td>
</tr>
<tr>
<td>Energy</td>
<td>5</td>
<td>4%</td>
</tr>
<tr>
<td>Healthy immune system</td>
<td>4</td>
<td>3%</td>
</tr>
<tr>
<td>Joints</td>
<td>3</td>
<td>3%</td>
</tr>
<tr>
<td>Eyesight</td>
<td>3</td>
<td>3%</td>
</tr>
<tr>
<td>Prevent cancer</td>
<td>3</td>
<td>3%</td>
</tr>
<tr>
<td>Regulates blood pressure</td>
<td>3</td>
<td>3%</td>
</tr>
<tr>
<td>Muscle strength</td>
<td>2</td>
<td>2%</td>
</tr>
<tr>
<td>Normal neurological function</td>
<td>2</td>
<td>2%</td>
</tr>
<tr>
<td>Well-balanced diet</td>
<td>1</td>
<td>1%</td>
</tr>
<tr>
<td>Storage of calcium</td>
<td>1</td>
<td>1%</td>
</tr>
<tr>
<td>Normal liver function</td>
<td>1</td>
<td>1%</td>
</tr>
<tr>
<td>Protection from sunburn</td>
<td>1</td>
<td>1%</td>
</tr>
<tr>
<td>Helps reduce weight</td>
<td>1</td>
<td>1%</td>
</tr>
<tr>
<td>Melanin synthesis</td>
<td>1</td>
<td>1%</td>
</tr>
<tr>
<td>Thin legs and big belly if lack of vitamin D</td>
<td>1</td>
<td>1%</td>
</tr>
</tbody>
</table>

All responses were provided as free text entries in the survey, and grouped together based on the type of benefit mentioned.
Figure 1: The number of survey participants who believe that darker skin pigmentation is a risk factor for vitamin D deficiency (p=0.023)

Comparison across groups was made using a Chi-Square test
Table 3: Acceptance rates for the mandatory fortification of foods with vitamin D by survey participants, as indicated by the percentage responding yes to each statement.

<table>
<thead>
<tr>
<th>Statement</th>
<th>South Asians</th>
<th>Blacks</th>
<th>Over 65 years</th>
<th>Arabic/Middle Eastern</th>
<th>Far Eastern</th>
<th>Caucasian British</th>
<th>Chi square result</th>
</tr>
</thead>
<tbody>
<tr>
<td>If the government introduced law to fortify some foods with vitamin D, would this influence your choice of purchasing these foods?*</td>
<td>48%</td>
<td>68%</td>
<td>50%</td>
<td>67%</td>
<td>73%</td>
<td>29%</td>
<td>p = 0.004</td>
</tr>
<tr>
<td>If the government introduced law to fortify all cow’s milk with vitamin D, would this influence your choice of purchasing this food?</td>
<td>36%</td>
<td>55%</td>
<td>50%</td>
<td>57%</td>
<td>73%</td>
<td>29%</td>
<td>p = 0.004</td>
</tr>
<tr>
<td>If the government introduced law to fortify all UK varieties of bread with vitamin D, would this influence your choice of purchasing this food?</td>
<td>40%</td>
<td>55%</td>
<td>30%</td>
<td>52%</td>
<td>73%</td>
<td>33%</td>
<td>p = 0.003</td>
</tr>
</tbody>
</table>

Comparisons across groups was made using a Chi-Square test