Abstract

Purpose

As natural dietary sources of vitamin D are not consumed in sufficient quantities, fortified foods could play a role in maintaining vitamin D sufficiency. With public consultation an integral part of designing acceptable fortification strategies, this study aimed to understand public awareness and perception of vitamin D fortified foods.

Methodology

A mixed-methods approach was taken with two focus groups and 109 surveys conducted using a non-probability sample from North-East England. Thematic analysis of focus group data identified 6 themes, with factor and cluster analysis identifying 7 factors and 4 clusters respectively, which highlighted differences in vitamin D knowledge and fortified food perceptions.

Findings

Despite identifying sunlight as the main vitamin D source (91%), participants were less aware of the main dietary source (33%), and few could state fortified products (51%). Although attitudes towards fortification were generally favourable (63% agreeing that selected products should be fortified), nearly half (43%) were unsure if more products should be made available. Results suggest that more natural products to complement existing market offerings would be most preferred. Factor and cluster analysis results identified awareness of health benefits and/or dietary sources as essential to have favourable attitudes towards fortified products.

Originality/value

This research adds to the limited literature regarding consumer attitudes towards fortified foods. It highlights a need to improve public awareness and labelling of fortified products to potentially increase fortified food consumption.

Keywords: vitamin D, fortification, consumer attitudes, consumer behaviour, fortified foods
1. Introduction

Vitamin D is well-known for its role in musculoskeletal health and is thought to play a role in the prevention and treatment of a multitude of diseases (Borradale and Kimlin, 2009, Chowdhury et al., 2014). Despite its growing role in human health, high rates of inadequate vitamin D intakes exist within Europe, with intakes less than the estimated average requirement ranging between 50 and 100% dependent on the country (Viñas et al., 2011), with the UK and other countries of northerly latitude at higher risk (EFSA Panel on Dietetic Products and Allergies, 2016). This is due to a lack of adequate UVB-sunlight for around half the year, and lifestyle factors that can also increase the deficiency risk (Ashwell et al., 2010, Holick and Chen, 2008). Hence, dietary sources of vitamin D have the potential to provide an effective way to increase and maintain population vitamin D intakes (O'Donnell et al., 2008).

In 2016 a RNI (reference nutrient intake) of 10μg/ day for adults was set for the first time by the UK Scientific Advisory Committee for Nutrition (SACN, 2016). It is extremely difficult for the UK population to reach this level of intake based on food intakes of vitamin D in the UK (Bates et al., 2014), with average dietary intake levels of vitamin D are not half of this (Black et al., 2012), averaging only 4μg/ day in the UK (Bates et al., 2014). Only those aged 65 years or over averaging over 3μg/ day, according to the National Diet and Nutrition Survey (2018), only a third of the recommended intake. As dietary vitamin D sources are not consumed frequently enough to ensure the RNI, urgent dietary-based strategies, which may include advice on nutritional supplementation and fortification are needed (SACN, 2016).

A systematic review by O'Donnell et al. (2008), and a more recent summary by Hayes and Cashman (2017), have concluded that fortified foods can significantly increase vitamin D levels when consumed regularly. Epidemiological studies have found that a country’s fortification policy can be used as a primary predictor of their population’s vitamin D status, with countries, such as
Finland, that have mandatory fortification practices having higher dietary intakes than those with voluntary/no fortification (Calvo et al., 2005, Gibson, 2003, Jääskeläinen et al., 2017). In the UK, where voluntary fortification practices exist, in line with European Regulation (EC) No.1925/2006, with breakfast cereals alone having been found to contribute between 10-20% of the average intake of vitamin D for adults, and similar amounts in young adolescents (Ashwell et al., 2010, Borradale and Kimlin, 2009, Gibson, 2003, Macdonald et al., 2008, National Diet and Nutrition Survey, 2018), and are the 4th largest contributor to dietary vitamin D intake, after meat, eggs and fish (National Diet and Nutrition Survey, 2018).

A review of currently available fortified products conducted by the first author, from seven different supermarket retailers in the Newcastle-upon-Tyne area was conducted, by either visiting the websites of the leading supermarkets with online shopping systems, visiting stores and contacting retailers directly for more information about product ranges (Table 1). Products contained varying amounts of vitamin D, with the minimum amount being 15% of the RNI, as per European Regulation (EC) No.1925/2006. This search highlights that although there are many products offered, the range is limited, with most products being dairy or cereal based. This is somewhat reflective in terms of the fortified foods known to contribute most to dietary vitamin D intakes (Ashwell et al., 2010). It does however, indicate a gap in the market for other product types to complement these and the small range of naturally occurring dietary vitamin D sources.

Table 1: A summary of the vitamin D fortified products available in the UK, (as of June 2012)

Source: authors’ own construction.
In lieu of recent increased public health recommendations on vitamin D, food manufacturers are responding, and are introducing fortified or reformulated products, in an attempt to appeal to and add value for customers *inter alia* (Kellogg’s, 2011, Marks and Spencer, 2016). However, limited research has been conducted which examines consumers’ awareness of vitamin D and its associated health benefits, or consumer awareness and perceptions of fortified foods. With the potential for fortified foods to increase vitamin D intakes, it is important to understand consumer’s attitudes so that the most effective fortification practices possible can be put into place and; to identify the most appropriate food vehicles to fortify.

Against this background, this paper aims to: (i) establish consumer awareness of vitamin D, its sources and associated health conditions; (ii) establish consumer awareness and perception of vitamin D fortified foods; and (iii) establish purchasing preferences of fortified foods in Newcastle-upon-Tyne.

2. **Material and Methods**

2.1. **Focus groups**

Ethical approval was obtained from the authors’ institution prior to commencement of all research. Focus groups were conducted to enable both in-depth perspectives to be obtained and to inform a larger survey, with the latter used to enable market segmentation and further analysis of the data. Two focus groups were conducted following recommendations for good practice (Morgan, 1998). A non-probability sample was drawn from the local area, with a mixture of ages and genders purposively chosen to obtain a wide range of opinions. All provided signed consent in line with the University’s ethical policy. Focus groups were conducted at the authors’ institution and recorded to enable transcription.

A semi-structured approach was taken to facilitate discussion around key topics surrounding vitamin D identified in a literature review, and to enable comparison between focus groups.
Opened-ended questions were used to direct participants’ conversation about vitamin D awareness in the media, knowledge on vitamin D sources, benefits of consuming vitamin D, associated health care conditions, awareness of vitamin D fortified foods and perceptions of fortification. Hand-outs showing the fortified products in Table 1 were used to establish participant awareness.

2.2. Survey

The survey was informed by the product search and current literature, with specific subject areas relating to participant characteristics, awareness and knowledge of vitamin D and health, sources of vitamin D, vitamin D in the media and participant awareness and opinions towards vitamin D fortified foods. A section of the survey also re-addressed these issues in the form of 24 statements based on a 5-point Likert Scale (where 1 = strongly disagree and 5 = strongly agree) with a sixth option of “don’t know” requested and confirmed by piloting.

Participants were selected using a non-probability sampling approach, to enable a representative sample as possible in relation to the city’s population. Participants were recruited from several locations around the city. The survey was carried out face-to-face, resulting in 109 participants being recruited.

2.3. Data analysis

A thematic approach (Braun and Clarke, 2006, Thomas and Harden, 2008) was used to analyse focus group transcripts. This is a process whereby the researcher freely, and inductively codes data based on the emerging and recurrent themes from the data itself. These codes were then grouped into key. Analysis was conducted in Microsoft Word.

All statistical analysis was carried out using SPSS statistical software (SPSS, 2010), including descriptive statistics. Factor analysis was conducted on the 24 statements. This is an interdependence technique used to identify the common variance and underlying structure between variables, and so implies that grouped variables are highly correlated with each other (Hair et al.,
Cluster analysis was then used to segment participants based on the factors obtained from the preceding analysis. Cluster analysis groups people together based on a shared or similar variables (Hair et al., 2010). Segments/clusters will have small ‘distances’ between themselves and large ‘distances’ between persons in other clusters (Li et al., 2011). These segments allowed for the identification of those who are most/least receptive to vitamin D fortified products, and those with the most/least awareness of vitamin D. Firstly, a hierarchical cluster analysis was chosen to determine the number of clusters to use in subsequent analysis, and this maximises the difference amongst cases in different clusters compared to alternative solutions. Next, a K-means cluster analysis was used to identify clusters of participants using the factors obtained in the previous analysis, with Analysis of Variance (ANOVA) being used to test for differences between factors across clusters. Finally, Chi-square analysis, using socio-demographic characteristics and other survey questions, was used to profile each segment, by looking for differences across the clusters identified.

3. Results

3.1. Focus Groups

Focus groups were attended by 6 and 7 participants respectively, of mixed age (18 – 61 years) and gender (7 male and 6 female participants). A summary of themes that emerged from the thematic analysis is presented in Table 2.

Table 2: Summary of themes from the focus group discussions
All, but the youngest participants, were aware that sunlight is the main source of vitamin D, with bone health and general health being the most common benefits mentioned. Younger participants (19-23 years) were particularly unaware of the health conditions associated with vitamin D deficiency, with older participants referring to health conditions more prevalent when they were younger.

"Participant 2: Rickets, that’s from too little sunshine, it was a problem when we were younger ... I think it is coming back now though, perhaps from too much suncream?"

"Participant 1: and from too much time spent indoors on games”

The perceived general low awareness, as one participant suggested, could be because the symptoms of deficiency are not immediately obvious, therefore, individuals may not be aware of the increased health risks as a consequence of deficiency. This contrasts with the risks associated with too much sun exposure, which are obvious and well-publicised within the media, i.e. sunburn and skin cancer. No participants perceived themselves to be at risk from deficiency, citing others such as children, those that work indoors and the elderly as most at risk, as they were least likely to go outside. This highlights most individuals may not be aware that they are at risk from deficiency, and so may not be taking the necessary actions to improve their vitamin D status.

Oily fish, margarine, red meat and selected breakfast cereals were all named as dietary sources, with participants highlighting that foods clearly advertised as containing vitamin D, were the only ones thought to be voluntarily fortified. Participants were therefore surprised by the number of fortified products available when provided with the hand-outs. Despite their low awareness participants expressed a willingness-to-purchase fortified foods. However, they would not switch.
products/brands to obtain more vitamin D, with other product attributes such as taste and nutritional content (e.g. fat/calories), being more important.

Although participants were reluctant to change habits/swap products to improve vitamin D intakes, participants, especially the younger participants, would consider purchasing fortified snack products, as they felt these would be easier to incorporate into their lifestyles. This was reflected in the products they would like to see fortified, such as cakes, biscuits, chocolate and water.

Despite citing supplements as an easier way to obtain sufficient vitamin D most participants felt reluctant about taking these.

“Don’t most supplements give you more than what you’d need in a day? It’s just a waste because you’d eat it in your diet as well”

Participant 3, FG 2

This also highlights concerns about over-consumption and associated adverse effects. Participants would also not increase their sun exposure time to increase their vitamin D levels, describing the risks of additional sunlight exposure as outweighing the benefits of increasing their vitamin D levels.

“I would rather be safe and wear sun cream than get a tan, and not get vitamin D”

Participant 1, FG 1

“Cancer is cancer ....”

Participant 4, FG 2

3.2. Survey results

Table 3: Overview of survey participant characteristics

<INSERT TABLE 3 HERE>
In total 109 responses were obtained. Most participants (93.6%) were white reflecting the Newcastle-upon-Tyne population (87.3%) (ONS, 2001). Over half of participants were female (63%). Under half (43%) had an undergraduate or postgraduate degree, with only 13% educated to a minimum of GCSE or equivalent. Over two thirds of participants (68%) had some form of responsibility for shopping.

Most participants (91%) knew sunlight was the main source of vitamin D and almost all (96%) associated inadequate sun exposure with deficiency. Fewer participants (87%) associated inadequate dietary consumption with deficiency, although a similar percentage (85%) knew (strongly agreed/agreed) that it was important to include vitamin D in the diet.

A third of participants (33%) correctly identified oily-fish as the main dietary source. Other commonly cited dietary sources were dairy products (15%) and breakfast cereals (13%) with misconceptions, such as fruit (11%) and vegetables (13%), also mentioned. This is in line with focus group findings.

Over three quarters of participants (76%) associated health benefits with optimum vitamin D levels, the majority of these being bone health (45%), which was also cited in conjunction with a multitude of other diseases. A minority of participants (4%) were aware of health benefits although they were unsure as to specifically what these were. In addition, 76% of participants associated health risks with deficiency, mostly related to bone health.

Participants were largely unaware of the factors that increase the risk of deficiency, with just over half (51%) identifying the elderly as being at an increased risk. Again, this is in line with the focus group findings where the elderly was also mentioned as an at-risk group.
Over half of the sample (51%) was aware of products fortified with vitamin D, with breakfast cereals the most commonly cited (47%), which supports focus group findings. 39% participants mentioned multiple foods, such as cereals, spreads and yoghurts, matching the foods mentioned in the focus groups. Breakfast cereals (Kellogg’s cereals specifically) were the most common food known to advertise that they are fortified followed by yogurts and spreads. Misconceptions existed, with bread and Sunny D (a soft drink) mentioned as fortified foods with vitamin D by 5% participants.

As with the focus groups most participants (76%) would not prefer supplements to fortified products, either because they do not take or do not like taking supplements or they would prefer to obtain vitamin D from a more natural source. For those who preferred supplements (40%), the two main reasons were they are an easy way to make sure that you are getting enough, and that it enables you to make a conscious decision to consume vitamin D.

3.3. Purchasing habits and preferences

Participants seemed in favour of fortification in general (63% agree/strongly agree that selected food products should be fortified with vitamin D and 55% of participants strongly agreed/agreed that fortification was a good idea), however there was a mixed reaction to whether more fortified products should be made available. Less than half (43%) were unsure if this was a good idea and 10% disagreed. This links in with the majority (73%) of participants ideally wanting to obtain vitamin D from natural sources, and so not necessarily looking to fortified foods to increase their intake.

Breakfast cereals were the only type of food product mostly preferred to be fortified with vitamin D. For all the other types of food product the majority response was “no preference”.

3.4. Segmentation analysis

3.4.1. Factor analysis

Within the survey, 24 statements were analysed by factor analysis. A Kaiser-Meyer-Olkin index of 0.743 deemed data to be sufficiently correlated. Bartlett’s test of sphericity led to the rejection of the null hypothesis which was that the test variables were not correlated ($\chi^2 (276) = 1514.709, p = 0.000$). This produced seven factors with a robust cumulative variance of 73.3%, above the 60% required for analysis to continue. All communalities were greater than 0.5 and all variables had reasonable factor loading scores (Table 4) so all were included in analysis. A scree plot confirmed the seven factors. Mean factor scores (Table 5) were obtained using the summated scales technique and saved for cluster analysis. A summary of each factor is subsequently provided.

<INSERT TABLE 4 HERE> **Table 4: Factors and associated statements**

Factor 1, *broad knowledge*, refers to individuals who have a greater knowledge of vitamin D, due to the association of statements concerning the specific health risks, such as cardiovascular disease.

Factor 2, *pro-fortified foods*, contains individuals who are willing to purchase vitamin D fortified products. They also feel that fortification is a good idea, especially due to the negative loading for the statement “*I do not like the idea of vitamin D fortified products*”.

Individuals in factor 3, *healthy diet*, know that vitamin D can be obtained through the diet, and, to a lesser extent, believe that it is important to include it in the diet. They also believe that they are aware of vitamin D.

Individuals in factor 4, *general knowledge*, are aware that vitamin D is beneficial to bone health, and has additional health benefits, although not in specific detail.
Factor 5, *anti-supplements*, covers individuals who would not prefer to take supplements to get the vitamin D they need, due to the negative factor loading score. These individuals are also aware that the main source of vitamin D is sunlight.

Individuals in factor 6, *natural sources*, would prefer to obtain vitamin D from natural sources. They also have a greater than basic knowledge of the health benefits of vitamin D.

Factor 7, *unaware of benefits*, is only associated with one statement indicating that individuals are unaware of the health benefits associated with vitamin D.

<INSERT TABLE 5 HERE> **Table 5: Mean factor scores**

Factor scores show participants were most likely to agree with factor 3 (*healthy diet*), implying that they agree that vitamin D can be obtained from the diet and that including it in the diet is important. This implies that participants are more likely have a basic general knowledge of the importance of vitamin D and are likely to buy fortified foods, although would ultimately prefer to obtain vitamin D from natural sources, hence why they are unlikely to take supplements. Participants were most likely to disagree with factor 7 (*unaware of benefits*) indicating they associate health benefits with vitamin D. The small standard deviation also indicates that there was little variance in response.

### 3.4.2. Cluster analysis

A 4-cluster solution was obtained by the agglomeration schedule in the hierarchical cluster analysis, which was then used in the K-means cluster analysis on the 7 factors previously obtained. ANOVA results indicated that factors 3 and 4 as having no significant differences between clusters (Table 6).
A summary for each cluster is presented in Table 7. Cluster 1 was the only cluster where 40% or more of individuals would not purchase fortified foods (for each product category mentioned). Hence, this cluster were the least likely to purchase such foods. This could be because this is the only cluster where most participants (60%) were unaware of the benefits of optimal vitamin D intake, and where only half had heard about the vitamin D in general (awareness was 90% or above for all other clusters). This was also the cluster of individuals most likely to sunbathe or work outdoors. They would therefore benefit from information how to maximise safe sun exposure, throughout the summer months.

Cluster 2 was the only one where individuals would prefer to obtain their vitamin D from natural sources, although they are the least likely to do so based on their self-reported levels of outdoor activity. Individuals in this cluster were most aware of the benefits associated with optimal vitamin D levels and of current fortified foods, perhaps because they were the most likely (33%) to have heard about vitamin D in newspapers/magazines.

Individuals in cluster 3 were the least likely to agree that they have a broad knowledge of vitamin D, despite 77% of them associating health benefits with optimum vitamin D levels. They were also the most likely to agree to purchase fortified foods.

Even with the majority (79%) of individuals in cluster 4 agreeing there are health benefits associated with vitamin D, they were most likely to agree that they are unaware of specific health benefits (factor 7), indicating a lack of confidence and depth in knowledge. This could be reinforced through providing information.
What is apparent from the analysis is, that in order to have favourable purchase intentions towards vitamin D fortified foods, participants need to be aware of the importance of obtaining it through the diet and/or understand the health benefits associated with optimum vitamin D levels. The only cluster which failed to do so was cluster 1, which had a negative purchase intention towards all product categories listed.

Table 7: A summary of the four clusters in relation to participant characteristics

4. Discussion

Vitamin D deficiency in the UK is due to several factors including latitude, lifestyle factors and low consumption of vitamin D rich foods (Borradale and Kimlin, 2009, Calvo et al., 2004). The higher RNI’s set recently mean the percentage with vitamin D intakes less than the recommendation has increased. These factors increase the importance of dietary vitamin D, particularly fortified foods.

Therefore, it is important to identify appropriate and convenient staple foods that could be fortified as in the case of the UK, the whole population is at risk of deficiency (Calvo et al., 2005, Chief Medical Officers for the UK, 2012, Yach, 2008). To do this, it is vital to understand consumer’s awareness of currently fortified products and their perceptions of foods to fortify. This study aimed to investigate awareness and perception of vitamin D and vitamin D fortified foods in Newcastle-upon-Tyne.

Participants only had a basic knowledge of vitamin D, as despite most being correctly identifying its main source (sunlight), only a third could correctly identified the main dietary source (oily fish), and aside from bone health, there was a general lack of knowledge of health benefits from vitamin
D sufficiency. Given that the results of the analysis indicate that individuals need to be aware of the importance of obtaining vitamin D through the diet and/or understand the health benefits associated with optimum vitamin D levels, the lack of knowledge present indicates that the public may not take advantage of voluntarily fortified foods on the market, as they are not aware of the need for them.

This is further supported by none of the participants perceiving themselves to be at risk of deficiency, due to the risk factors they identified. Individuals may therefore not perceive a need to increase their vitamin D intakes through supplementation, sunlight exposure or dietary sources. Together these findings indicate a need for greater education around how to obtain vitamin D and maintain sufficient levels, with a greater emphasis of the health benefits of doing so, especially in light of far higher recommended intakes now than previously.

A preference for obtaining vitamin D from natural sources was identified. However, given that dietary sources were not well recognised and focus group participants were reluctant to gain more sunlight exposure to improve vitamin D levels, believing that the risks associated with sunlight offset the benefits, maintaining vitamin D levels through natural approaches is unlikely to be a successful strategy, especially given the limited options available (Black et al., 2012, Cashman and Kiely, 2016). Vitamin D supplementation was not preferred by the majority of participants, with most preferring fortified products to supplements. This was either because they do not take/like taking supplements, or they would prefer to obtain vitamin D from a perceived more natural source, such as fortified foods. These findings align with previous research which showed that individuals do not like taking tablets (Mintel, 2011), and that compliance with supplementation is low (Cashman and Kiely, 2014). This indicates that supplementation is unlikely to be a population wide solution to tackling rates of deficiency, and further emphasises the need for population appropriate and publicly acceptable fortification strategies.
In order to enable the public to identify vitamin D fortified products, misconceptions surrounding natural and fortified sources of vitamin D should be addressed, such as raising awareness regarding which foods are naturally vitamin D rich, and what product types should be consumed, perhaps by adopting clearer labelling policies to aid dietary choices. This reflects findings by Tedstone et al. (2007) where study participants had a preference for a clear and simple labelling strategy for folic acid fortified products, to enable consumer choice. This again emphasises a need for greater information dissemination surrounding vitamin D.

Fortification would appear to be an acceptable strategy to increase vitamin D intake. However, awareness of existing fortified foods was low with the well-known sources reflecting the most common product categories in Table 1, which are also known to contribute towards vitamin D levels (Ashwell et al., 2010, Borradole and Kimlin, 2009, Macdonald et al., 2008).

Participants were largely equivocal in relation to the product types they would prefer to purchase, with breakfast cereals the most preferred, most likely due to participants’ familiarity with them. Although these are a staple product, given more recent discussions as to their healthiness due to their sugar content (Dent, 2018, Pombo-Rodrigues et al., 2017), care should be taken as the promotion of these products as a healthier source due to their added vitamin content. This also relates to the preferred products for fortification mentioned in the focus groups, which were high in calories, sugar and fat. Limited clear preferences, and a predisposition for more familiar foods, suggests staple products would be suitable to fortify. This would act to ensure fortified food items are consumed on a regular enough basis to be beneficial. Calvo and Whiting (2006) echo this, with their calls to ensure that a wider range of products are fortified, so the whole population can benefit, and that fortification practices meet the need of all population groups (Kiely and Black, 2012). It is therefore essential to ensure the most appropriate products, including consideration of their other macronutrient properties, are identified if positive health effects of fortified foods are to be realised. Within this there is also a need to ensure the pricing of fortified products does not act as a barrier to
purchase and subsequently ensure equitable access to fortified products. Therefore, the most cost-effective solutions to fortification should be explored.

The identified preferences for natural solutions implies a role for biofortification (Cashman, 2015), which may appear more natural to consumers and provides a means for a wider array of products to be fortified, to account for a greater diversity in dietary preferences and eating habits. Applications include vitamin D eggs (Hayes et al., 2016), bread and mushrooms (Cashman, 2015), although more research is needed to test their acceptability and efficacy.

To summarise, results of this research indicate a need for more information surrounding sources of vitamin D and the health benefits from consuming optimal levels. Educational and promotional materials should therefore focus on highlighting health benefits of optimum vitamin D levels and how vitamin D can be included in the diet, since these are pre-requisites for more favourable attitudes. Clear and consistent labelling practices should be implemented to ensure consumers can easily identify and purchase fortified products. This would complement any fortification strategies in place and act to reinforce knowledge currently held by individuals and would mean consumers could potentially make small changes which could impact upon their vitamin D status.

This research confirms vitamin D awareness (at least in the studied areas) is low. These findings are important for developing knowledge and information strategies needed to address the rise in deficiency especially in regions more at risk, such as the UK. Given the low vitamin D intakes in the UK, insights into consumer’s behaviour and preferences are of particularly importance, especially as there is very little research into this subject area from a consumer perspective.

Therefore, this investigation provides a unique insight into consumer preferences and awareness of vitamin D, in an area that is at an increased risk of deficiency (O'Donnell et al., 2008).

Future research should examine the link between knowledge and purchase intentions, to establish whether increasing knowledge would act to improve vitamin D intakes alone, and whether changes
to labelling would increase awareness and purchase of fortified products. The acceptability of new products should also be assessed, and at-risk groups consulted to identify appropriate products to be fortified, relevant to their cultural and dietary preferences. Preferences for, and the acceptability of, both voluntary and mandatory fortification should be also explored within this.

As with any study, there were limitations. Due to the pilot nature of the research, small sample sizes were used, and the products included in the research only contained a snapshot of what is available on the market at one time. Despite this a large amount of data was obtained from both methods and provided detailed insights into this particular cohort.

5. Conclusion

To have successful fortification practices it is important to identify appropriate foods to reach the target population. This study aimed to explore consumer’s awareness and perceptions of vitamin D and vitamin D fortified foods in Newcastle-upon-Tyne, an area of the UK, at increased risk of deficiency. Results suggest more natural products to complement existing market offerings would be most preferred. Moreover, the results indicate the importance of awareness and knowledge of the health benefits associated with vitamin D to have favourable attitude towards fortified products, and potentially increase consumption. Findings indicate that although most participants were aware of vitamin D in general, they were less aware of the risks and benefits of suboptimal and optimal vitamin D levels, and of dietary sources. These findings are important as they highlight gaps in current public knowledge and indicate that members of the public would accept fortified foods as a means to improving their vitamin D intake.

6. References


CHIEF MEDICAL OFFICERS FOR THE UK 2012. Vitamin D – advice on supplements for at risk groups.


eggs are protective of wintertime serum 25-hydroxyvitamin D in a randomized controlled trial of adults, 2. *The American journal of clinical nutrition*, 104, 629-637.


ONS. 2001. *Resident population estimates by broad age band* [Online]. Available: [http://neighbourhood.statistics.gov.uk/dissemination/LeadTableView.do?z=3&b=276796&c=Newcastle+upon+Tyne&d=13&e=13&g=367418&i=1001x1003x1004&m=0&r=1&s=1329737183350&enc=1&dsFamilyId=1818](http://neighbourhood.statistics.gov.uk/dissemination/LeadTableView.do?z=3&b=276796&c=Newcastle+upon+Tyne&d=13&e=13&g=367418&i=1001x1003x1004&m=0&r=1&s=1329737183350&enc=1&dsFamilyId=1818) [Accessed 20th February 2012].


