Original Article

Impact of dietary acculturation among Saudi students in Glasgow

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ABSTRACT

Dietary acculturation is the term used to describe the adoption by a group of people of the eating patterns associated with a new environment. Dietary transition in minority populations can refer both to migrants arriving and acculturating in a new country, and to indigenous ethnic minority groups within a society undergoing acculturation. This study aimed to identify and measure the impact of dietary acculturation on weight changes amongst Saudi students in Glasgow. An observational study method was adopted wherein a face-to-face questionnaire was used to gather data from participants. In total, 42 participants were recruited and divided into two groups, namely: Saudi students who were residents in Glasgow for more than one year (n=25), and Saudi students who were residents in Glasgow for less than 3 months. The majority of students in both groups reported their weight had increased since they arrived in Glasgow, although there was a slight difference between the two groups (>one-year and <3 months). The major differences were that the intake of low-fat dairy products was higher in the >one-year group than in the <3 months group [semi-skimmed milk (P=0.012) and skimmed milk (P= 0.003)], and the intake of brown bread and cereals was higher in the >one-year group than in the <3 months group (P=0.047). The risk of diet-related obesity in the >one-year group was lower than in <3 months group. Hence, this study offers valuable descriptions and measurements of the dietary habits of Saudi students in Glasgow.

Keywords: Dietary acculturation, Risk of obesity, Saudi students, Glasgow, New country

Introduction

The prevalence of obesity

Research has shown that behavior-related modifications in areas such as diet, physical activity, and smoking have had a tremendous impact on public health over recent decades [1, 2]. Specifically, increased obesity has been linked to a rise in the number of cases of type 2 diabetes, cardiovascular disease, and certain forms of cancer [3, 4]. The upsurge in obesity now comprises a major public health issue. Consequently, the World Health Organization (WHO) has encouraged its member states to implement voluntary targets designed to reduce the global incidence of obesity by 2025 [5].

Research by Amin *et al*. (2008) revealed that 16% of Saudi children aged 6 to 18 are clinically obese [6]. In 2016, 35% of adults in Saudi Arabia were obese [7]. According to Musaiger (2011), obesity in Middle Eastern regions is typically the result of surplus energy intake and insufficient physical activity [8].

Similarly, in Scotland, the prevalence of obesity has also undergone a discernible rise in recent years. Research has revealed that 65% of Scottish adults are overweight, 28% being classed as obese [9]. Moreover, the incidence of obesity increases with age.

The etiology of obesity

In accordance with the parameters defined by the Scottish Intercollegiate Guidelines Network (SIGN), obesity is typified by

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the amassing of disproportionate body fat, which has implications for multiple organs in the human body [10]. Sánchez-García *et al*. (2007) suggested that obesity can be adopted as an indicator of the nutritional condition of a nation's adult population [11]. Moreover, according to Buchan *et al*. (2006), obesity is a consequence of an interaction between several environmental, cultural, behavioral, metabolic, genetic, and socioeconomic variables [12]. In addition, different eating patterns, such a meal frequency, omitting breakfast, and food types all have the potential to impact weight maintenance.

Dietary acculturation

Dietary acculturation or transition denotes the adoption by groups of people of the eating patterns which characterize a new social milieu. In relation to minority populations, the concept of dietary transition can be applied to migrants who arrive in a new country and acculturate to it or to indigenous minority groups within a society [13]. According to Satia-Abouta *et al*. (2002), the dietary acculturation process transitions through several stages, ranging from persistence with traditional eating habits through the complete adoption of the eating habits of the dominant culture which is typically a western one [14]. The final stage in the process comprises a conscious attempt to adopt a healthy diet and lifestyle.

The dietary transition has been shown to impact the incidence of a number of chronic health conditions and to lead to a sharp increase in chronic illness [14]. This phenomenon has been suggested as the underlying cause of obesity amongst Filipino American immigrants in New Jersey wherein dietary changes have negatively influenced their health status [15]. This was confirmed in the research conducted by Bakhsh (2014) wherein the impact of dietary acculturation on Saudi students was recorded in the United States. Specifically, students were shown to accrue significant weight gains when they adopted western eating habits [16].

Obesity co-morbidities

Obesity is a condition with the potential to have significant negative implications for life expectancy and quality [17, 18]. The associated conditions and comorbidities are extensive. For example, research by Nguyen *et al*. (2012) suggested that for every one kilogram of weight gain and the risk of cardiovascular disease rises by 3.1%, the risk of diabetes increases by between 4.5% and 9% [19]. The consequences of obesity exceed the impacts of smoking or problem drinking in these risk areas and have been shown to exacerbate the risk of other chronic health conditions, thereby diminishing the overall quality of individuals who are obese [20].

The increased risk of developing type 2 diabetes as obesity increases has been shown by multiple studies [19, 21, 22]. In addition, there is a correlation between obesity and the development of a number of cancers, including breast, ovarian, colorectal, oesophageal, kidney, pancreatic, prostate, and endometrial cancers [22, 23]. Obesity also increases the likelihood that individuals will experience strokes, hypertension, dyslipidemia, coronary artery disease, congestive heart failure, and pulmonary embolisms [19, 21, 24]. Moreover, there is an established link between obesity or excessive weight gain and conditions such as chronic back pain, gallbladder disease, osteoarthritis, non-alcoholic liver disease, and asthma [19, 25].

The implications of dietary acculturation in respect of multiple non-contagious health conditions are potentially enormous due to the correlation between dietary acculturation and obesity. The impetus for the current study originated with a desire to examine the dietary implications for Saudi Arabian students of studying in new environments. It is worth noting that international students are predisposed to experiencing reduced or elevated levels of dietary acculturation in accordance with the length of their residence in their new environments.

Materials and Methods

Study design

The primary method employed in the current study comprises the use of a pre-existing questionnaire [Norfolk Food Frequency Questionnaire (FFQ)]. The research was conducted at the start of the 2017/2018 academic year. Data were collected through the administration of face-to-face reported questionnaires using predetermined forms.

The inclusion criteria required that all student participants were both from Saudi Arabia and residents in Glasgow at the time of the research. Hence, the confidence interval was 95% with a 5% margin for error. The sample size was <41, in accordance with the Raosoft sample size indicator. Specifically, the sample comprised 42 Saudi students aged 18 to 50. In addition, the sample was divided into two sub-groups, to wit: students who had been resident in Glasgow for over one-year (n=25) and students who had resided in Glasgow for a period of fewer than three months (n=17). All the students received funding from the Saudi government and were living independently in Glasgow without any family members.

The exclusion criteria included the students under any medical supervision or suffering from any chronic illness. Smokers and women who had given birth within the previous twelve months were also excluded. The study consists of a valuable comparison between newly arrived students who have yet to fully acquire local eating habits and those who had been resident in Glasgow for an extended period. All participants underwent a physical evaluation at baseline, which was 7 October 2018, in order to record anthropometric data about weight and height. The latter was gauged using a Stadiometer (SECA 213) with the participants facing forwards in a standing position with shoes removed, shoulders relaxed, and backs to the wall. In order to measure the weight of each student, the participants were required to wear minimal clothing. Weights were gauged using a Tanita TBF-310GS Total Body Composition Analyzer. All measuring procedures were duplicated and averaged in order to arrive at a consistent and accurate measurement.

Statistical analysis

The data were analyzed using the Statistical Package for the Social Sciences (SPSS) software version 23 and the graphs and tables were generated with the assistance of Excel software. The correspondence of the demographic data was tested using a chi-square test, whilst the p-value was located with the use of an independent-samples t-test.

Ethical approval for the research was granted by the School of Health and Life Sciences Research Ethics Committee at Glasgow Caledonian University (GCU) in the United Kingdom, with the reference number HLS/LS/A16/003.

Results and Discussion

In **Table 1**, out of the 42 Saudi students, 22 (52.83%) were male students who had been living in Glasgow for more than a year, which was the majority of the sample, while 9 (21.34%) were male students who had been living for less than 3 months in Glasgow. On the other hand, the female students were about a quarter (n= 11) of the whole sample; 19% (n= 8) of them were in Glasgow for more than a year, while the rest (n= 3) were there for less than 3 months. There was a statistically significant difference between these two groups in terms of gender through using the chi-square test (P= 0.011).

Table 1. sample characteristics for participants who completed the questionnaire

characteristics	*Groups* >one-year (total=25)	*Groups* <3 months (total= 17)	P-value*
Gender			
Male	52.83% (22)	21.34% (9)	**P= 0.011**
Female	7.14% (3)	19.05% (8)	
Age (years)			
18-25y	2.38% (1)	16.67% (7)	**P= 0.020**
26-30y	26.19% (11)	14.29% (6)	
31-40y	28.57% (12)	9.52% (4)	
40-50y	2.38% (1)	0% (0)	

* Chi-square test (level of significant 0.05).

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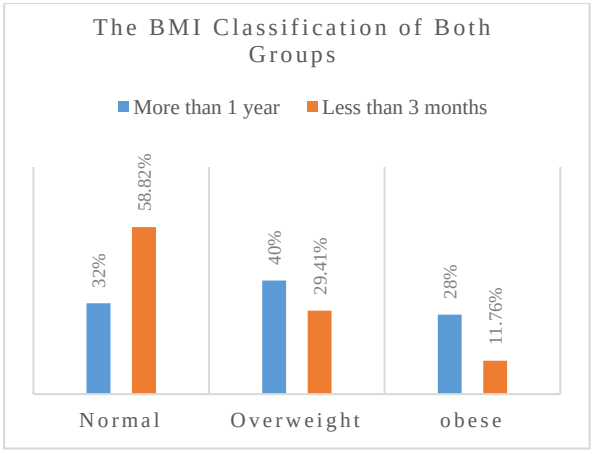

Figure 1. illustrates the classification of participates body weight in both groups (>one- year and <3 months) according the body mass index (BMI).

There was also a significant difference between both groups in terms of age (P=0.020). The highest figure (number of participants) was accounted for those aged between 26-30 years old, being 11 (>one-year) and 6 (<3months) for the two groups, respectively. Those older than 30 years old were also relatively the same in number, 13 (>one-year) and 4 (<3 months), respectively. Only eight out of the entire sample were accounted for the young age group (18-25y), being 1 (>one-year) and 7 (<3 months), respectively.

Figure 1 illustrates that more than half (58.8%) of those who have been in Glasgow for less than 3 months were at a normal weight, and the rest were overweight (29.41%) and obese (11.76%). On the other hand, 40% of those who have been in Glasgow for longer than a year were overweight, whilst 60% accounted for normal and obese at about 32% and 28%, respectively. It should be highlighted that there was no underweight participant in the entire sample.

Weight stability of student since being in Glasgow

Figure 2 shows the answers to the question, which asks about the weight status of the participants since they moved to Glasgow. There was a statistically significant difference between the groups with regard to the answer to this question (P= 0.036). It can be seen that the majority of the students opted for 'YES, HAS INCREASED', while the second place was for 'NO, STILL THE SAME', and the third was for 'YES, HAS DECREASED'.

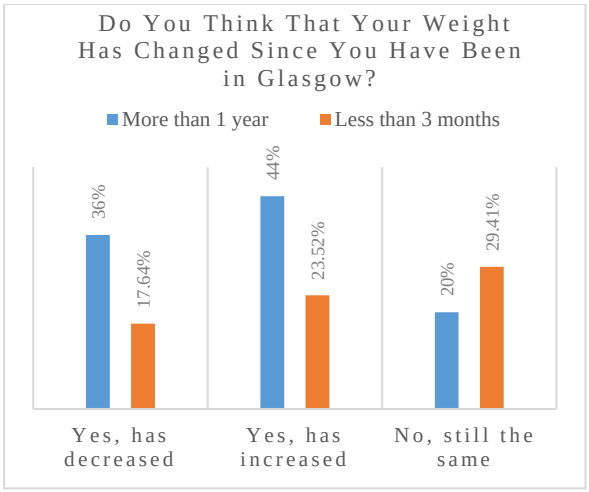

Figure 2. Stability of participants weights

Dietary intake

In **Figure 3**, it can be seen that the highest percentage of students consumed between 2-3 meals generally. However, 40% of the more than a year group tended to eat 2-3 meals, while for the other group (<3 months) the percentage was 35.29%. Similarly, 35.29% of the less than 3 months group were consuming 3-4 meals, yet it was just 20% for the more than a year group. The 1 to 2 meals option was chosen by 36% and 29.42% for the more than one-year and less than 3 months groups, respectively. 4% of the more than one-year students group were eating more than 5

meals a day. None of the students were consuming 1 meal or 4 to 5 meals a day. There was no statistically significant difference between both groups in terms of the number of meals during a typical day (P= 0.621).

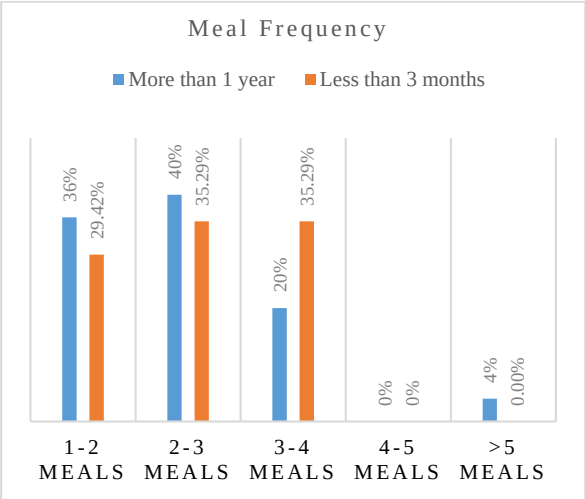

Figure 3. Meal frequency of both groups (>one-year and <3 months).

In terms of breakfast, the vast majority of the students were consuming their breakfast before going to university or school. Those who had been in Glasgow for more than a year were the highest percentage having their breakfast, at about 68%, while the figure is slightly less for the other group (< 3months), at about 64.701%. Those who were not consuming their breakfast regularly accounted for the minority percentage at about 32% and 35.30% of more than one-year and less than 3 months groups, respectively **(Figure 4)**.

Most of them attributed this to 'not having any appetite in the morning' [28.57% (> one-year) and 35.71% (<3 months)], whilst others attributed it to 'not having any time for breakfast' [28% (>one-year) and 7.14% (<3 months)] **Figure 5**.

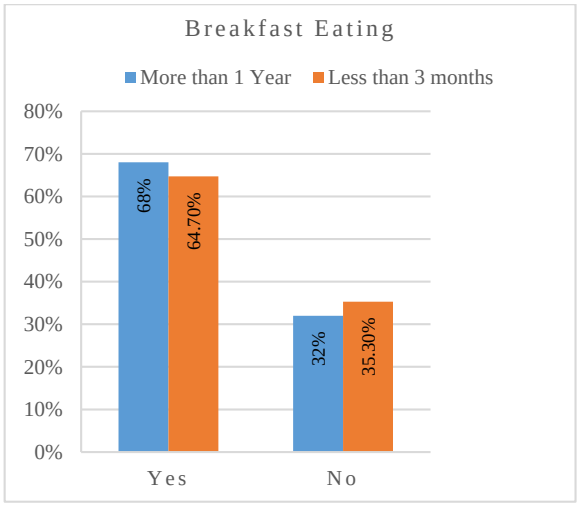

Figure 4. The consumption of breakfast for both groups (>one-year and <3 months).

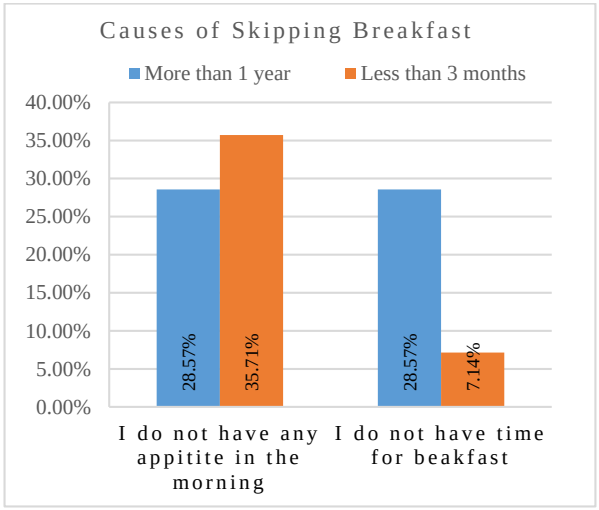

Figure 5. causes of skipping breakfast among both groups (>one-year and <3 months).

Dairy products

Figure 6 illustrates the intake of dairy products and fats of the more than a year group, while **Figure 7** illustrates the intake for the less than 3 months group. Generally, it can be recognized that there was a high intake of some dairy products and fats including eggs and cheese, e.g. cheddar, in both groups (>one-year and <3 months), at about an average 3.28, 3.41, 3.24, and 2.76, respectively. In contrast, the intake of cheese for the more than one-year group was 44% often consumed, while it was about 5.88% of often intake. However, there was no significant difference between them in the average intake.

The only statistically significant differences in the intake of dairy products and fats were found in milk, involving semi-skimmed milk and skimmed milk. On average 2.48 (>one-year) was consuming semi-skim milk, as opposed to 1.35 on average for the less than 3 months group (P= 0.012). Similarly, skim milk was consumed by about 2.12 on average for the one-year and more group, while it decreased in the less than 3 months group to about 1.12 on average, with a significant difference (P=0.003). It should be noted that 48% of the longer than a year group never consumed skim milk, while this figure for the less than 3 months group was 88%. The same applied to semi-skim milk, which just above half of the more than a year group never or rarely consuming it, while for the less than 3 months group the figure was more than four-fifths. No one from the more than one-year group consumed double cream often (3-5/week), while this percentage increased in the less than 3 months group to 11.76%. Overall, the consumption of low-fat dairy products is lower than the consumption of full-fat products to some extent.

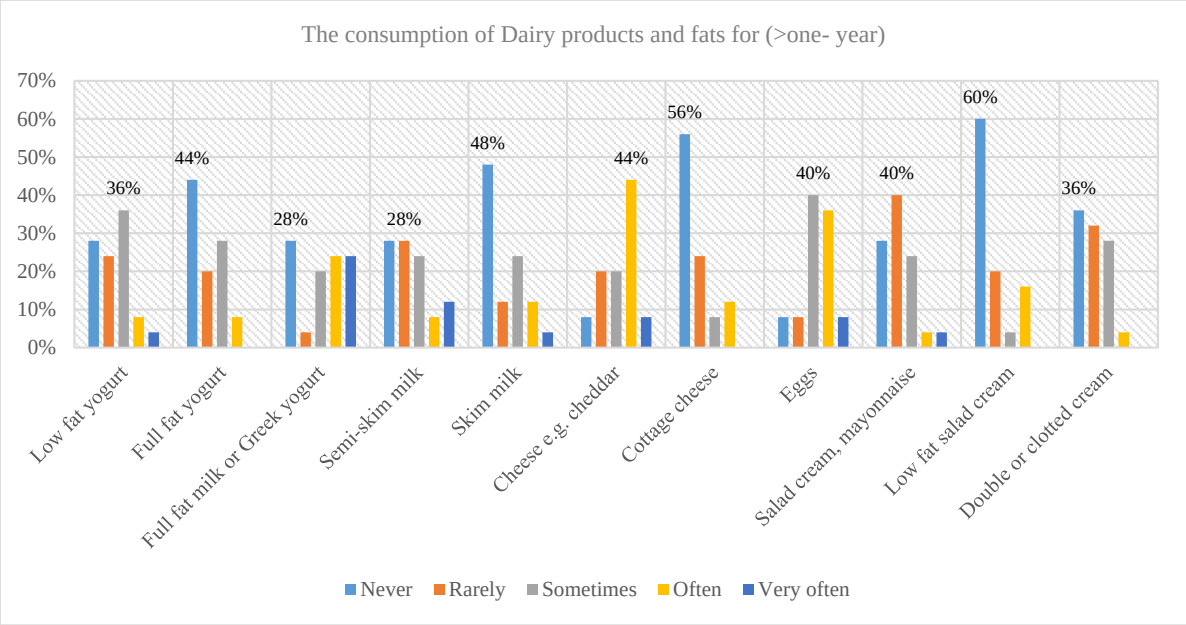

Figure 6. The consumption of dairy products and fats estimated by the dietary intake section in the questionnaire for more than one-year group (n=25), the highest percentages are indicated in the below figure.

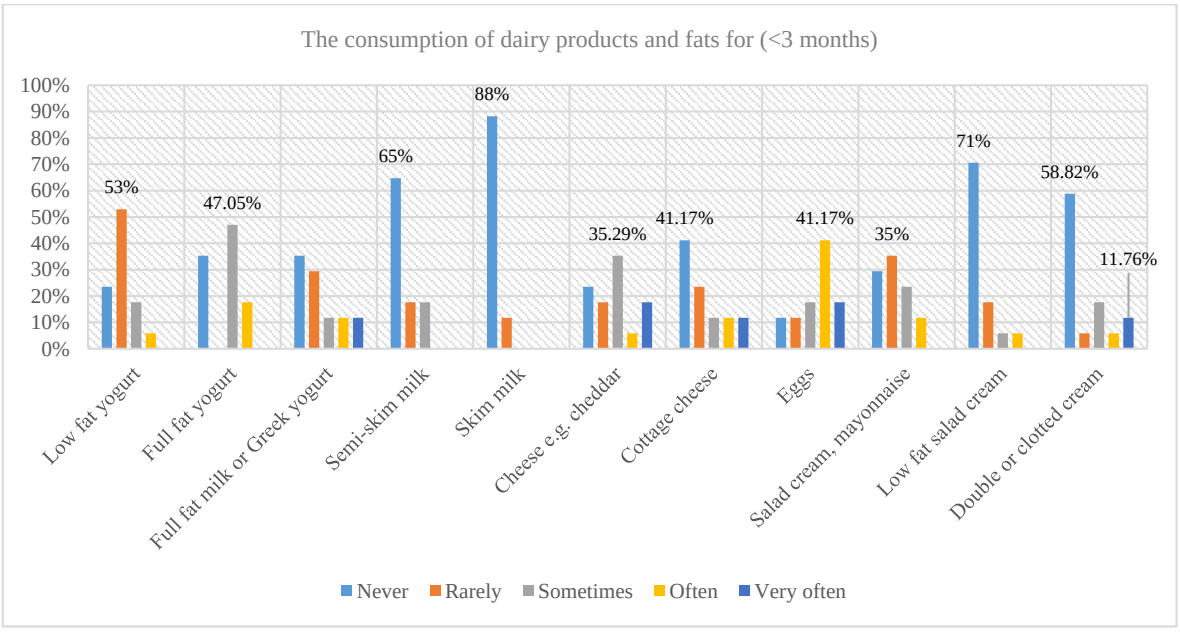

Figure 7. The consumption of dairy products and fats estimated by the dietary intake section in the questionnaire for less than 3 months group (n=17), the highest percentages are indicated in the below figure.

Meat and fish

The intake of fried fish often (3-5/week) increased in the more than one-year group to 8%, while for the less than 3 months group, it was 0%. Unexpectedly, the percentage of those who never consume oily fish in the less than 3 months group was about 41.17%, while it was just more than half (56%) for the other group (>one-year). For other types of fish, two-thirds or the less than 3 months group never or rarely consume it, against two-thirds of the more than one-year group who sometimes or often consume it.

Chicken consumption in both groups was almost the same at 12% and 11.76% (>one-year and <3 months, respectively). On the other hand, those who said they never ate beef decreased from 24% in the less than 3 months group to be half of this figure in the more than one-year group, while there was a slight difference in beef burger intake in both groups by about. The intake of the liver is significantly low in both groups (on average 1.44± 0.154 for >one-year and 1.71± 0.223 for <3 months).

Bread and cereals

The intake of bread and cereals in both groups was similar and there were no statistical differences between them. However, the percentage of white bread intake in the less than 3 months group was 41.17% very often, while 32% of the more than one-year group consume it sometimes. For brown bread, more than half of the less than 3 months group never or rarely consume it,

against more than two-thirds of the more than the one-year group, who sometimes and often consume it. The final type of bread is wholemeal bread. It was interesting to find that more than two-thirds of the less than 3 months group never or rarely consume wholemeal bread, while just above half of the more than one-year group consumed it sometimes or often. Finally, the intake of pizza differed slightly in both groups, with an average consumption of 2.72±0.169 (>one-year) and 2.35±0.242 (<3 months). The only statistically difference found between the two groups in bread and cereals intake was for brown bread (P=0.047)

Fruits and vegetable consumption

All of the Saudi students in Glasgow consume fruits and vegetables. Of more than one-year group, 16% consumed fruits and vegetables very often, against 35.29% of less than 3 months students. Indeed, the average intake of fruits and vegetables for both groups was often (3-5/week), 3.65± 0.284 (<3 months) and 3.60± 0.163 (>one-year). In opposition to this, a few students were rarely consuming fruits and vegetables, certainly, 4% (>one-year) and 17.64% (<3 months). There were no significant differences (P= 0.879).

Drinks

The consumption of spring water was similar in both groups with non-significant statistical differences (P= 0.486). In addition, There were no statistical differences in terms of flavored water and its intake in both groups was low, about 8% of the more than one-year group were consuming it very often (>1/day) against 0% in less than 3 months. However, the intake of tea was very high in both groups. On average, 4.00± 0.271 was the consumption of more than one-year group, while it was 3.59± 0.322 for less than 3 months group with statistically insignificant differences (P= 0.335). Likewise, coffee intake was on average 4.16± 0.243 (>one-year) and 3.65± 0.363 (<3 months) with no significant differences (P= 0.229). Nevertheless, more than half of more than one-year group were consuming coffee every day, against just less than half of the other group. Drinking fizzy drinks was slightly common, whilst those who drink fizzy drinks every day were approximately the same in both groups (~12%). On the other hand, the low-calorie drinks were not popular among Saudi students in both groups as 82% (<3 months) and 52% (>one-year) never consumed them. However, those who sometimes consumed low-calorie drinks (1-2/week) were about 16% of the more than one year group, compared to 0% of the other group. For pure fruits, the intake was almost the same in both groups.

Body Mass Index and the duration of stay in Glasgow

As far as weight is concerned, the mean BMI of the entire sample was 27.9 kg/m^2, which is considered overweight. However, as close to 60% of the less than 3 months group were at a normal weight, against just above 65% being obese or overweight in the other group (>one-year); this means that the duration of living in Glasgow has a link with an increase in the BMI of Saudi students in Glasgow, despite the fact that the mean BMI of both groups was considered as overweight. This could be interpreted to mean, as the last Scottish survey 18 indicated, that being in Scotland the level of obesity among all age groups is increasing year by year (Scottish Health Survey 2015).

Dietary intake

Meal frequency and breakfast

The results of this study showed that the majority of Saudi students were consuming from 2 to 3 meals a day in both groups, which is similar to the results of [26], which clarified that Saudi students tend to eat 2 main meals a day. It has been suggested that eating from 3 up to 5 small meals a day on a regular basis is associated with a reduction in obesity and overweight risk [27, 28]. By contrast, [29] disputed that and considered this interpretation as one of many myths and presumptions about diet and health, and also saw difficulty for this to be characterized with any generality, which in fact is supported by [30], who attributed the potential effect on obesity risk to eating or skipping breakfast. To sum up, the lack of scientific evidence on this point would be the cause behind this argument.

The benefits of breakfast have been extensively studied, and the findings suggest that it has a positive effect on cognitive performance [31], feeling of wellbeing [32], and weight management [33], as well as some chronic diseases such as cardiovascular disease and type 2 diabetes [34]. The debate, currently, is about what could be considered to be a nutritive breakfast or nutrient-dense breakfast, as well as towards the appropriate definition of breakfast and skipping breakfast [35].

Dairy products

In terms of dairy products, it has been found that dairy products and dietary calcium intake have an 'antiobesity' effect [36]. The increase of dietary calcium, especially from dairy products, without restricting energy density of the diet, appears to be a reason for repartitioning of dietary energy from fat tissue to lean body mass, which, finally, results in a reduction in body fat mass [37]. In other words, dairy products are a good source of calcium, potassium, and energy would likely decrease the effect of dense energy and poor nutrient diets, which have been found likely to cause obesity [38]. In this study, it seems that those who have been in Glasgow for more than a year were consuming dairy products in higher quantities than the other group; certainly, low-fat dairy products, which actually have a higher nutrition density than full-fat products. The relatively higher intake of low-fat dairy products among longer than one-year students may be because of the availability of these products in food shops in the UK. While, for the other group who have just recently come to Glasgow, the cause of low intake could be the insufficiency of

such products in their home country (Saudi Arabia), so that they were not familiar with these. The fat products such as cheese (cheddar and cottage), egg, and salad cream were highly consumed by the more than one-year group, which may increase the risk of obesity as these are commonly used with fast foods.

It is recommended for an adult to consume 700 mg/d (Reference Nutrient Intakes) of calcium [39]. This means that dairy products should be taken every single day to achieve this recommendation, which equals 3 cups of milk.

Meat and fish

The intake of fried fish increased to about three to five times a week for 8% of participants in the more than one-year group to 8%, while for the less than 3 months group it was 0%. Unexpectedly, the percentage of those who never consumed oily fish in the less than 3 months group was about 41.17%, while it was 56% for the other group (>one-year). For other types of fish, two-thirds of the less than 3 months group never or rarely consumed it, as opposed to two-thirds of the more than the one-year group, who sometimes or often consumed it.

Chicken consumption in both groups was almost identical at 12% (>one-year) and 11.76% (<3 months). In contrast, those who said they never ate beef accounted for 24% of the less than 3 months group, a figure, which was halved in the more than one-year group. There was a slight difference in beef burger intake in both groups. The intake of liver is significantly low in both groups, being on average 1.44± 0.154 for the >one-year group and 1.71±0.223 for the <3 months group.

Bread and cereals

The intake of bread and cereals was similar in both groups and there were no statistical differences between them. However, the percentage of white bread intake in the less than 3 months group was 41.17% (very often consumed), compared with 32% for the more than one-year group (sometimes consumed). More than half of the less than 3 months group never or rarely consumed brown bread, compared with more than two-thirds of the more than the one-year group, who sometimes or often consumed it. Interestingly, over two-thirds of the less than 3 months group never or rarely consume wholemeal bread, while just above half of the more than one-year group consumed wholemeal bread either sometimes or often. However, there were no statistically significant differences between the groups. The consumption of brown rice was low in both groups. Finally, the intake of pizza differed slightly between the groups, with an average consumption of 2.72±0.169 (>one-year) and 2.35± 0.242 (<3 months). The only statistical difference found between the two groups with respect to bread and cereal intake related to the consumption of brown bread (P=0.047).

Fruit and vegetable consumption

All of the Saudi students in Glasgow consumed both fruit and vegetables. In the more than one-year group, 16% of participants consumed fruit and vegetables very often, as opposed to 35.29% of participants in the less than 3 months group. Furthermore, the average intake of fruit and vegetables for both groups classed as often (3-5/week), was 3.65±0.284 (<3 months) and 3.60±0.163 (>one-year). Conversely, a small number of students rarely consumed any fruit or vegetables, the figures for this group being 4% (>one-year) and 17.64% (<3 months). There were no significant differences (P= 0.879).

Drinks

The consumption of spring water was similar in both groups with non-significant statistical differences (P= 0.486). In addition, there were no statistical differences in terms of flavored water and its intake in both groups was low. Approximately 8% of the more than year group were consuming it very often (>1/day) compared with 0% in the less than 3 months group. However, the intake of tea was very high in both groups. On average, consumption for the more than one-year group was 4.00± 0.271, whereas it was 3.59± 0.322 for the less than 3 months group. There was no statistically significant difference (P= 0.335). Likewise, average coffee intake was 4.16± 0.243 (>one-year) and 3.65± 0.363 (<3 months), with no significant difference (P= 0.229). Nevertheless, over half of the more than one-year group were consuming coffee every day, compared with just under half of the other group. The consumption of fizzy drinks was moderately common, with the proportion who consumed fizzy drinks every day being roughly comparable in both groups (~12%). Conversely, the low-calorie drinks were not popular among Saudi students in either group. Thus, 82% (<3 months) and 52% (>one-year) of participants never consumed these products. However, those who sometimes consumed low-calorie drinks (1-2/week) represented 16% of the more than year group, compared to 0% of the other group. In respect of pure fruit drinks, consumption was almost identical in both groups.

In relation to weight, the mean BMI of the entire sample was 27.9 kg/m2, which is regarded as overweight. However, almost 60% of the less than 3 months group were of normal weight, whereas just over 65% of the other group (>one-year) were obese or overweight. This suggests that there is a correlation between the length of residence in Glasgow and an increase in the BMI of Saudi students, despite the fact that the mean BMI of both groups equated to being overweight. These findings accord with the last Scottish survey, which indicated the level of obesity among all age groups in Scotland is increasing year on year [9].

Dietary intake

Meal frequency and breakfast

The results of this study showed that the majority of Saudi students were consuming from 2 to 3 meals a day in both groups, which is similar to the results which emerged from the research conducted by Al-Rethaiaa *et al*. (2010) [26]. Thus, Saudi students

tend to eat 2 main meals a day. It has been suggested that eating from 3 up to 5 small meals a day on a regular basis is associated with a reduction in obesity and the risk of being overweight risk [27, 28]. This conclusion has been disputed by Mattson *et al*. (2014) who suggested that this interpretation is one of many myths and presumptions about diet and health [29]. Mattson *et al*. (2014) also stated that it is difficult to assert this presumption about frequent small meals in any generalized way [29]. According to Casazza *et al*. (2013), there is a potential link between obesity risk and eating or skipping breakfast [30]. It would appear that the scientific evidence on this point is the root cause of disagreement on this subject.

The benefits of breakfast have been extensively studied, and the findings suggest that it has a positive effect on cognitive performance [31], feelings of wellbeing [32], weight management [33, 40], and certain chronic diseases such as cardiovascular disease and type 2 diabetes [34]. The debate, currently, is about what could be considered to be a nutritive breakfast or nutrient-dense breakfast, as well as towards the appropriate definition of breakfast and skipping breakfast [35, 40].

Dairy products

It has been found that dairy products and dietary calcium intake have an anti-obesity effect [36, 41]. Increased dietary calcium, especially in the form of dairy products, without restricting the energy density of the diet, appears to be one reason for the repartitioning of dietary energy from fat tissue to lean body mass, thereby causing a reduction in body fat mass [37]. In other words, dairy products are a good source of calcium, potassium, and energy and are also likely to decrease the effect of dense energy and poor nutrient diets, which have been found likely to cause obesity [38, 41]. This study revealed that those who had been in Glasgow for more than a year were consuming dairy products in higher quantities than the other group. This was particularly true with respect to low-fat dairy products, which are actually having a higher nutrition density than full-fat products. The relatively higher intake of low-fat dairy products amongst the longer than one-year students may have been due to the availability of these products in food shops in the UK. Conversely, the comparative cause of low intake amongst the other group could be the result of the lack of availability of such products in their home country, which rendered these students unfamiliar with the products. High-fat products, such as cheese (cheddar and cottage), eggs, and salad cream, were consumed at high levels by the more than one-year group, thereby increasing the risk of obesity because these food types are commonly associated with the consumption of fast foods.

It is recommended that adults consume 700 mg/d (Reference Nutrient Intakes) of calcium [39]. In order to achieve this goal, dairy products equivalent to three cups of milk should be consumed every single day.

Meat and fish

In general, meat intake is high in Saudi Arabia, which is linked to an increased risk of obesity among the Saudi population [42, 43]. Interestingly, rates of fish and meat consumption in this study remained relatively unaltered for both groups, despite the fact that Muslim students must eat Halal meat, which is available only in a limited number of shops. The intake of meat and fish is moderately high amongst Saudi students. The intake of fish differed slightly between the groups, wherein the more than one-year group consumed slightly more fish than the other group. Oily fish was the most popular type of fish for both groups.

Bread and cereals

The results reveal that the intake of bread and cereals increased for both groups, with those who have been in Glasgow for more than a year regarding the typical Scottish diet as being low in cereals. Brown and wholemeal bread and brown rice were consumed at a high level by the more than one-year group, compared to the less than 3 months group. In fact, there is evidence that the intake of high-fibre and whole-grain foods is negatively associated with weight gain, while refined grains are positively associated with weight gain and obesity [44, 45]. On the other hand, however, the intake of refined grains like white bread and rice increased in the more than one-year group, compared to the other group. Interestingly, the consumption of different types of bread and cereals increased, which would be a reflection of the variety available in Glasgow shops.

Pizza and chips were consumed at a higher level by the more than one-year group due to the high availability of takeaway restaurants in Glasgow, where these kinds of food are the main items on the menu. Furthermore, this might explain why the intake of fish increased among the more than one-year group since the popular food in Scotland is fish and chips. This accords with the finding that Greeks students in Glasgow also consume high levels of fish and chips [46].

Fruits and vegetables

The consumption of fruit and vegetables was slightly lower for the more than one-year group compared with the less than 3 months group. The same finding was observed regarding the consumption of pure fruit juice (100% juice). In fact, these changes in the intake of fresh fruit and fruit juice were also observed amongst Greek students in Glasgow [46].

Beverages

The intake of coffee and tea was high in both groups, which may also be because of the nature of the sample. Specifically, Arab students tend to drink a lot of Arabic coffee, even in Glasgow. In addition, the plethora of coffee shops in Glasgow might serve to actually enhance the intake of coffee and tea of various types. It has been estimated that, in 2013, 1.7 million cups of coffee were bought in the UK [47], which may explain the high intake of coffee amongst the sample participants. Increased coffee and tea intake are inversely associated with weight gain over a period of

12 years for men and women. This observation was not linked to the caffeine content in coffee and tea [48].

In terms of fizzy drinks (sweetened drinks), the intake of both groups was the same, whereby over 30% of both groups were consuming fizzy drinks more than 4 times a week. It has been suggested that consuming fizzy drinks 4 times or more per week can increase the total energy intake compared to less than 3 times per week [49]. The association between a high intake of fizzy drinks and the development of obesity has been well established [50]. According to Ashwell *et al*., (2020) and Miller & Perez (2014), replacing regular-calorie drinks with low-calorie drinks would have a modest effect on losing weight and could lead to a relative reduction in energy intake [51, 52]. The impact of low-calorie drinks on body weight appears close to the impact of natural water [53].

Limitations

There are a number of limitations in the present study. The sample size was small. Another weakness was that this survey did not address the issue of the portion or serving sizes in the questionnaire thereby rendering it more difficult to calculate, assess, and compare the nutritional content of the diets of the participant students.

Conclusion

The present study investigated the effects of dietary acculturation on weight changes among Saudi students in Glasgow by measuring the dietary patterns of those who have been in Glasgow for more than one year and those who have been in Glasgow for less than three months. In general, it seems that those who have been in Glasgow for more than a year are at a lower risk of obesity than those who have been there less than three months, in respect of their dietary patterns. However, the mean BMI of those who have been in Glasgow for more than one year is higher than that of the other group. These findings enhanced the current understanding of the changes in dietary habits of Saudi students in Glasgow, which is generally characterized by a slight increase in the intake of low-fat dairy products, high-fiber bread, and cereals (brown rice and brown wholemeal bread). Some dietary habits remain unchanged, such as meal frequency during a typical day and the intake of coffee, tea, fizzy drinks, water, white rice, white bread, fruits, vegetables, meat, and fish. The changes in BMI may be attributed to the variety of food options available in Glasgow, combined with other factors, such as changes in physical activity. The latter would comprise a valuable subject for future research. It is anticipated that the current study will be of assistance in the development of educational interventions designed to support the maintenance of healthy weight and to prevent obesity in the period following immigration.

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