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The Changes In Dietary Patterns Of Saudi Women Residing In Saudi Arabia, South Korea, And The United States: The Effects Of Length Of Residency On Dietary Acculturation

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THE CHANGES IN DIETARY PATTERNS OF SAUDI WOMEN RESIDING IN SAUDI ARABIA, SOUTH KOREA, AND THE UNITED STATES: THE EFFECTS OF LENGTH OF RESIDENCY ON DIETARY ACCULTURATION

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DEDICATION

I dedicate this work:

To my beloved parents, Nourah and Abdullah, for your continuous prayers and unconditional love. For believing in me and for the unlimited matchless support. I am truly speechless when I think of how much appreciation I have for you. I am who I am today because of you!

To my husband, Ahmed, my companion in life and my crutches throughout this journey, for always being by my side through all the ups and downs. Without your support and passion, this dream would have never come true.

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CHAPTER 1: INTRODUCTION

Saudi Arabia (SA), more officially Kingdom of Saudi Arabia (KSA), is one of the largest countries in the Middle East with a population of over 30 million, and geographically, it comprises most of the Arabian Peninsula. As part of the country's development plans and to promote its human capital both educationally and professionally, KSA has launched an ambitious scholarship program in 2005 to send qualified students to leading countries in the field of academics such as the United States (US), United Kingdom and South Korea (KR). The effects of this program, however, have extended beyond educational and academic aspects to include cultural and even establishing trade and commercial relationships. Today, Saudi students represent the fourth largest nationality of international students to attend US universities, just behind China, India, and the KR. In addition to students, Saudi immigrants have shown an increase in the US. As of 2016, the number of Saudi immigrants to the US, including those who came for educational purposes, reached 100,000 individuals (Migration Policy Institute, 2018). Given these large and growing numbers of Saudi individuals living abroad, investigating how their dietary patterns have changed and have been influenced by acculturation with host countries, as well as the health consequences of these changes, is a research area that needs to be investigated.

Acculturation process is the direct, immediate, and interactive contact among people from dissimilar cultural backgrounds that leads to cultural change (Redfield, Linton, & Herskovits, 1936; Teske Jr & Nelson, 1974). It is the psychological, social, and economic changes that an individual undergoes in order to accommodate into the hosting culture (Berry, 1997; Graves, 1967). Acculturation involves several strategies, each of which has its own approach toward interaction with the host culture. Generally, two main dimensions exist that help decide which of these acculturation strategies to follow: cultural maintenance and contact-participation (Berry, 1997). The strategies as developed by Berry and colleagues include assimilation, separation, integration/biculturalism, and marginalization. When the individual abandons his\her culture of origin and fully assumes the traditions of the host culture, they would be applying the assimilation strategy. On the other hand, the separation strategy is when minority cultural traditions are maintained while omitting interaction with the dominant host culture. The integration/biculturalism strategy falls in between the previous two strategies, where the acculturating individual adheres to their traditional customs but maintains interactive contact with the hosting culture. The marginalization strategy, however, exhibits rejection of and alienation from both the minority and host cultures (Berry, 1994, 2001).

One aspect of acculturation is dietary acculturation where acculturating individuals follow the food practices and behaviors of the host culture under a dynamic and multidimensional process (Satia, 2010; Satia, Patterson, Neuhouser, & Elder, 2002; Satia et al., 2000). This transitioning process is a complex one and involves various dietary and health implications. It would also produce mixed effects as some immigrants would benefit from being introduced to new diets whereas other immigrant groups would be at disservice. An example of an advantageous effect is shown where Asian immigrants in the US adopted a western diet away from their customary high-sodium one, which would lower the risk for hypertension (Serafica, 2014). Comparatively, an instance where there would be a negative effect to adopting new diets at host countries is seen among Saudi immigrants in South Korea. Saudi immigrants to the KR might be exposed to high-sodium

Korean diet which would lead to high chances of hypertension among those groups (Al-Nozha et al., 2007; El Bcheraoui et al., 2014). These incidents would be very problematic especially given that adverse health effects among immigrants are very common (Satia, 2010), and increased acculturation incidents were found to be associated with unhealthy nutritional habits and chronic diseases (Satia et al., 2002; Serafica, 2014). These effects become more amplified among immigrant groups, such as Saudis, where chronic diseases such as cardiovascular diseases and diabetes are very frequent (Algabbani, Alqahtani, & BinDhim, 2019; Memish et al., 2014). Therefore, when these individuals become exposed to a new diet pattern in the host country, their chronic disease status may worsen regardless whether their underlying health problem was genetic or diet-related. Individuals born in the US or immigrated to the US since childhood may not experience similar drastic effects as they may have already customized their diets in response to their own chronic diseases condition. Also, western diet that is characterized by high fat and sugar content might increase immigrants' risks of chronic diseases (Serafica, 2014), especially vulnerable Arab immigrants who showed high prevalence of cardiovascular diseases in the host country (Hatahet, Khosla, & Fungwe, 2002). Dietary acculturation could be a factor that contributed to this prevalence of CVDs among Arabs as it also contributed to other health conditions among immigrants. This was observed in a study that suggested an association between dietary acculturation and increased body mass index (BMI) in Arab refugees in the US (Jen, Zhou, Arnetz, & Jamil, 2015). This study revealed post-migration increases in hypertension, body weight, and depression among Arab refugees as compared to pre-migrations.

The degree of dietary acculturation varies among immigrants. They may keep following their traditional diets from country of origin, adopt diets from host country, or combine both approaches. On special social gatherings, however, the inclination is more toward maintaining customary diets and avoiding that of the host culture (Pan, Dixon, Himburg, & Huffman, 1999). This was demonstrated in a study on 327 Korean Americans which showed that over half of them kept consuming their traditional foods, with most of the remaining individuals following a bicultural approach in their diets, and a lesser percentage being fully acculturated to western foods (S. K. Lee, 2008). Arab immigrants in western countries exhibited similar patterns by maintaining traditional foods and food preparation customs from their home countries (Aljaroudi, Horton, & Hanning, 2019; Garduno, 2015; Tami, Reed, Boylan, & Zvonkovic, 2012). In particular, Saudis' adherence to their traditional foods such as Kabsah, which is a main dish, may come as a result of their hospitality traditions and religious food restrictions. These customs may tend to widely control the extent of dietary acculturation among Saudis. Religious restrictions in the form of Halal foods are a crucial determinant in maintaining conventional Saudi and Arab Muslim diet. For example, it was reported that Arab Muslim mothers residing in Canada maintained traditional food items and preparations for their families (Aljaroudi et al., 2019). In addition to religious influences, marital status and employment are other factors that may affect dietary acculturation. Marital status may introduce new consumption habits and food choices among married couples as was reported by a study that husbands affected their wives' consumption levels (Worsley, 1988). Employment could also act as an influencing force on dietary intake patterns through its effect on income and affordability of certain foods (Milicic & DeCicca, 2017). These factors, individually or combined, may bring about changes in consumption habits that would reflect acculturation.

In contrast, there are other strong factors that may shift dietary patterns of Saudis toward the food choices in host countries. The extent of their integration into host communities is a crucial determinant of their lifestyle changes and dietary habits. Also, the availability of and accessibility to Arab ethnic groceries and restaurants, as well as lack of time to cook traditional dishes, are other important factors (Lv & Cason, 2004; Pan et al., 1999; Satia et al., 2000). It was reported in a study of about 400 first-generation Chinese Americans that more than half of them have changed their dietary behaviors mainly due to either a busy lifestyle and not having time to prepare traditional food, or limited access to traditional Chinese foods (Lv & Cason, 2004). More importantly, the length of time that immigrants live in the host country is a strong influential factor that shapes their dietary habits (Brittin & Obeidat, 2011; Lv & Cason, 2004). A study which included Saudi women immigrants in the US showed significant differences in their dietary patterns such as increasing consumption of fruit and vegetable as compared to their counterparts in Saudi Arabia. The differences were more significant between women who stayed in the US for more than 10 years and those who stayed for less than five years (Alqahtani, 2017). Similarly, Asian students who were in the US for more than three years showed bigger changes in their diets in comparison to those who stayed for less time (Pan et al., 1999).

Dietary patterns in Saudi Arabia have evolved over time as a result of several social and economic factors. Among these factors are the more westernized lifestyle among the population which inspired food choices away from traditional local food.

Additionally, as the population has become more urbanized with only limited numbers still living in rural areas, food patterns have shifted to refined food products and animal-derived foods. Specifically, people have switched away from healthy choices of low-fat and fiber-rich foods such as fruit, vegetables, wheat, and dates to unhealthy choices of high fat and low fiber foods (Musaiger, 2002). These transformations are reflected by a study that analyzed data published by the Food and Agriculture Organization (FAO) which showed increases in meat consumption but fluctuating consumption of fruit and vegetables in SA. This could be explained by increasing meat supply from 26 grams/capita/day in 1990 to 139 grams/capita/day in 2000 and decreasing vegetables supply from 400 grams/capita/day in 1990 to less than 250 grams/capita/day in 2000 in SA (Adam, Osama, & Muhammad, 2014). These pattern shifts among Saudis resulted in the majority of the population not satisfying the dietary recommendations set by the Saudi Health Interview Survey (SHIS) which are based on the guidelines from the US Department of Agriculture. In specific, only 5.2% and 7.5% of Saudis met the dietary recommendations for vegetables and fruits, respectively. A higher percentage of 44% met the recommendations for fish. High consumption of sugary beverages and processed foods are reported among young Saudis (Moradi-Lakeh et al., 2017).

Similarly, dietary recommendations are not widely met by the general US population. Diets that lack vegetables, fruits, and dairy food groups are observed in 80% of the population (Dietary Guidelines Advisory Committee, 2020). As for the protein and grains food groups, more than 50% of the population meet or exceed the recommendations. However, they do not meet grain and protein recommendations for certain subgroups. For example, intakes for whole grains subgroup were below recommendations but were over recommendations for refined grains subgroup. Also, intake for meat and eggs meet or exceed recommendations while seafood intake is below recommendations (Dietary Guidelines Advisory Committee, 2020).

Residents in Korea (KR) have their own distinguished food choices where rice is the most common element of the daily diet, along with seasoned or fermented vegetables. As for the source of protein, barbecued meat and fish come as popular choices in Korea (K. W. Lee & Cho, 2014).

Several observations are reported from the breakdown of food consumption by food items in SA, the US, and the KR as derived by the food balance sheet at Food and Agriculture Organization Statistics (FAOSTAT, 2018). While less popular in the US, rice comes as the main food item and staple food for the bulk of people around the world (Maclean, Hardy, & Hettel, 2013). Rice and its products consumption in the KR is the largest among the three countries with 119.47 kg/capita per year. In SA, where rice is almost indispensable on family tables and is a main component of many traditional meals such as Kabsah along with meat or chicken, consumption reached 55.58 kg/capita/year (FAOSTAT, 2018). SA appears to be consuming more wheat than rice (100.35 kg/capita per year vs 55.58) while the US coming next with 81.09 kg/capita per year in wheat consumption and the KR at 51.37 kg/capita per year (FAOSTAT, 2018). This is not surprising considering that wheat is an integral component of Saudi traditional dishes. Consumption of all different types of meat, however, was reported higher in the US at 123.14 kg/capita per year, more than double the amount of consumption in SA which amounts to 45.45 kg/capita, and higher than the 71.07 kg/capita per year in the KR (FAOSTAT, 2018). Clearly, these numbers reflect the popularity of burgers, hot dogs, and steaks in the US. Consumption of egg, milk, and sugar in the US also surpasses that of SA and the KR (FAOSTAT, 2018).

The incremental cases of Saudis living abroad and the potential resulting health issues make dietary acculturation emerge as a crucial research area. The active expatriation among Saudis in recent years along with the fact that it is a population among which chronic diseases are common makes them an important target for scientific research on dietary acculturation (Memish et al., 2014). Understanding their dietary patterns and changes over time in host countries may provide valuable perspective in understanding diet behaviors of similar and other populations and ethnicities. Also, this endeavor may aid in developing helpful and culturally-appropriate approaches to minimize the negative impact of acculturation among Arab immigrants.

CHAPTER 2 : OBJECTIVES AND HYPOTHESES

The objectives of this study were to compare the food intake/nutrient intake patterns of Saudi women residing in SA, the KR and the US. To achieve this objective, 24-hr dietary recalls were obtained from women residing in SA, KR and the US.

Objective 1: To test the hypothesis that the dietary patterns/nutrient intakes were different among women in the three countries.

We hypothesized that SA women in three countries would have different dietary patterns or nutrient intakes. The intake patterns would be different between participants who were employed or married as compared to those unemployed or single.

Objective 2: To test the hypothesis that the length of time since emigrating from SA was associated with a larger divergence from traditional SA dietary pattern.

We hypothesized that as the length of residency in the host countries increased, (a) participants' food/nutrient intake patterns would be associated with large divergence from their traditional food/nutrient intake when compared to those who remained in SA. (b) participants' food/nutrient intake patterns would become more similar to those of the host countries as compared to those newly arrived or those who remained in SA.

Aim 3: To test the hypothesis that participants' BMI levels were different among the three countries, and that the health-related parameters and

percentage of recommended intakes were different among the BMI categories.

We hypothesized that participants in KR would have lower BMIs as compared to participants in the US or SA. Obese participants in these countries would have higher fat and energy intakes than those with normal BMIs.

CHAPTER 3: METHODOLOGY

This study is a secondary analysis of cross-sectional 24-hour dietary recall data which were obtained from a previous study for a different objective (Alqahtani, 2017). The dietary analysis was not performed on these dietary recalls in the previous study. Those 24-hour dietary recalls were collected in 2015 by the primary investigator from Arab women who were originally from Iraq, Yemen, and SA and were residing in metropolitan Detroit, Michigan, U.S. Also, additional 24-hour dietary recalls were collected in the same period from SA women in SA and SA women in the KR, but the KR recalls were not included in the previous study. The scope of this research, however, was on those SA participants only, hence, this study includes convenience sample of SA women who were residing in SA, the US, and KR. The total number of participants was 100 distributed as follows: 48 residing in SA, 25 in the US, and 27 in the KR. Majority of these participants were university students, their spouses, or other SA women within the Arab community.

Convenience sample was obtained mainly through flyers that contained description of the study and contact information of the primary investigator. These flyers were distributed at college campuses, mosques, health clinics, and Arab stores in Arab community areas. Interested individuals then initiated contact with the investigator to participate in the study. Their eligibility to participate in the study was determined based on criteria that included: to be 18 years of age or older, their home country was Saudi Arabia, primarily had their meals at home, and were involved in meal planning for family. After the investigator obtained written consents from eligible participants, two interviews were scheduled at weekends and weekday evenings. Prior to these interviews, two sets of recording forms were given to the participants to record their past 24 hours intakes for one weekday and one weekend day as chosen by each participant (Appendix A and B). At the same time, instructions in both English and Arabic languages were given on how to list every food item that participants consumed during the past 24 hours. Helpful pictures were shown to each participant as to how to estimate the amount of each food consumed. In addition, demographic and health status data as well as number of meals and junk food were collected during the first visit as self-reported on the questionnaires (Jen, Zhou, Arnetz and Jamil, 2015, Appendix C).

In a follow-up interview, these record sheets were collected by the investigator who went over the records with each participant and used multiple pass methods to ascertain the accuracy of the recalls (Johnson, Driscoll, & Goran, 1996).

Food intake/nutrient intake patterns were analyzed using Food Processor software version 11.7.217 (ESHA Research, Salem, OR). Through this software, calorie, macronutrients, and micronutrients consumed daily were obtained. Also, as an indication of the dietary quality, the percentages of MyPlate recommendation, the intakes of sodium, and SAT (Saturated fat) were calculated through the software based on each participant's weight and height; whereas the percentage recommended added sugar was calculated manually based on the guideline suggested by the Food and Drug Administration (FDA) which is 50 grams a day per 2000 kcal. For the food items or dishes not in the Food Processor database (mostly Arab foods such as Kabsah, Sayadieh, and Foul), the original recipes were obtained from participants or approximated by common Saudi cooking methods. These recipes were then manually analyzed by each ingredient, commonly total cooked amount, and common serving size. After the two-day records were analyzed, the average of the two-day consumption of each nutrient was calculated and the average was used for all the statistical analyses.

The dietary recalls from SA and KR participants were collected by SA nutrition faculty in the King Abdul Aziz University, SA and Gachon University in KR.

The previous study protocol was approved by the Institutional Review Boards (IRB) of Wayne State University (WSU, Protocol#: 1502013781), King Abdul Aziz University (KAU), and Gachon University, Seoul, South Korea. Also, IRB approval was obtained from WSU for the secondary analysis (WSU, Protocol #: 20102790).

Statistical Analyses

Analyses of dietary recall data were performed using Statistical Package for Social Science (SPSS) version 25 (IBM Corp, Armonk, NY). The significance level was set at $p < .05$. All data were expressed as a mean ± standard error of means (SEM) or a mean ± standard deviation (SD). For junk food consumption, the p value missed to be significant, but the post-hoc Tukey tests were still presented here as they were reported in SPSS output.

For objective one: Several statistical analyses were used to assess objective one. One-way analysis of variance (ANOVA) was used to compare dietary intake differences among the three groups. If significant difference was found, post-hoc comparisons using Tukey tests were performed to identify the groups that contribute to the difference. Linear regression analysis was used to assess predictive values of the demographic parameters on dietary intake. Student’s t-tests were used to compare the association between marital status, employment status, and education levels on nutrient intakes for all participants combined, and also separately for participants living in each country. Chi-square tests were performed to examine the differences in distribution of demographic variables among the three groups. When a significant difference was identified in Chi-square test, binomial tests among the three groups were conducted, and p-values were adjusted for the multiple comparisons.

For objective two, general linear model analyses (two-way ANOVA) were performed to test the association between country and years of residency among Saudi women residing in the US and KR, and nutrient intakes and percent of recommended intakes. One-sample t-tests were used to determine if the SA participants in the US and in KR consumed similar or different amount of nutrients as compared to the consumptions in the US and KR general populations when the specific nutrient intake data for the general population were available.

For objective three, one-way ANOVA was used to compare BMI differences among the three groups. ANOVA were also conducted to assess associations between country, BMI, and their interaction, and nutrient intakes and percentage of MyPlate recommendations. Chi-square analysis was used to test if the distribution patterns of the categorical variables such as BMI and chronic diseases categories were different among women residing in the three countries. Student's t-tests were used to test the difference in mean BMI between individuals with and without the chronic diseases.

CHAPTER 4: RESULTS

Description of the Participants

The total number of participants was 100 women with the following breakdown: 48 residing in SA, 25 in the US, and 27 in the KR, and their ages ranged from 18-65 years. These participants were categorized based on length of residency in the host country: for less than or equal five years or more than five years. Most of these women were residing abroad for less than five years and most of them described themselves as White. More than 60% of the participants had college or graduate/professional degree education. The majority were unemployed as homemakers or students. Nearly 90% of the participants did not live alone, and the mean number of persons in the household was 3.5± 2.5 (mean± SD). Most participants were married, and the mean number of dependent children were 1.2 ± 1.5 (mean± SD). Forty-four percent of the dependent children were one to four year old while a little over half of them less than one year old. The distribution of demographic variables of all participants as well as in each of the three countries are presented in **Table 1**.

There was no difference in age distribution among the three countries (p=0.55). Distribution of education levels was significantly different among the three countries with the highest percent of participants in the US (92%) had at least some college education, and the least was those in SA (64.6%), with KR (77.8%) falling in between the US and SA groups (p=0.03).

When employment status was categorized into employed and unemployed, there was a significant difference in the distribution of employment status among the three groups ($p<.001$). Participants in the US had the lowest employment rate (4%), followed by KR (25.9%) and SA (56.3%).

More participants in the US (72%) and KR (66.7%) were married as compared to those in the SA group (45.8%). However, the difference among the three groups failed to reach statistical significance ($p=0.056$).

Description of the Participants' Health-Related Characteristics

Almost half of the participants had normal weight BMIs while the other half had either overweight or obese BMI's. There was no difference in mean BMI and BMI distributions among the participants in the three countries. Although the majority of the participants' self-rated health status was either excellent or very good, there was a significant difference in the distribution of self-rated health among the three groups ($p=0.04$) with KR group having higher "excellent" rating than the other two groups. There was no difference in self-rated health status between the US and SA groups **(Table 2)**. Over half of the participants reported having health insurance coverage.

Most of the participants were non-smokers. Over 70% reported not exercising intensively each week but reported doing moderate intensity exercises two to seven hours per week. Walking two to four hours a week was a common activity among more than 50% of the participants.

The majority of participants did not report having any chronic diseases, but there was presence of high blood pressure, high cholesterol, and dental problems at 12%, 15%, and 14% of participants, respectively. Meal frequency ranged from two to three meals per day among 50% of the participants. Over half of the participants self-reported that they consumed junk foods, which are foods that have low nutrient density and supplies calories through added sugars or fat, such as soft drinks, chewing gum, and candies (O'toole, Anderson, Miller, & Guthrie, 2007). Frequency of junk food consumption was from one to three times per week and about 30% reported consuming junk foods more than three times a week. Most of the participants spend more than $96 on groceries each week **(Table 3).**

Objective 1: To test the hypothesis that the dietary pattern/nutrient intakes were different among women in the three countries.

One way ANOVA and Post-Hoc Tukey tests were performed to compare dietary intake differences among the three groups. Data presented in **Table 4** showed that amounts of carbohydrate were significantly different among women in SA, the US, and KR. Saudi women in the US had the highest intake while women in KR the lowest. Saudi women in the US also consumed significantly more total fiber, total soluble fiber, sugar, monosaccharides, disaccharides, vitamin C, pantothenic acid, iron, manganese, and percentage of recommended fruit intake than Saudis in SA and the KR. Saudi women in the US consumed less junk food than Saudis in SA, however, the differences failed to reach significance. Saudi women in the KR consumed significantly less energy, oligosaccharide, vitamin B1 and percentage of recommended grain intake than Saudis in SA and the US. Saudi women in the US had significantly higher fluoride than that of women in the SA. Compared to Saudi women in SA, women in KR consumed significantly less vitamin B3, vitamin B6, magnesium, selenium and zinc. Also, compared to Saudi women in SA, women in KR consumed less added sugar, but the differences failed to reach significance. On the other hand, Saudi women in KR had lower percent of recommended added sugar intake and consumed significantly more vitamin A and vitamin K as compared to SA women in SA **(Table 4)**.

Multivariable linear regression analyses were performed to examine the associations between demographic variables and nutrient intake and percent of recommended dietary intakes (**Tables 5 and 6)**. The demographic variables that were used included age, number of years of residency, BMI, marital status, number of dependent children, education level, and employment status.

In the US, total added sugar intake was negatively predicted by marital status (married). The percentage of recommended fruit intake was negatively predicted by the education level, indicating the higher the education levels, the lower the consumption of fruit. The intake of the recommended dairy percentage was positively predicted by age and marital status. The intake of the recommended SAT fat intake was positively predicted by marital status (married), and negatively predicted by education level. The percentage of recommended added sugar was negatively predicted by marital status (**Tables 5 and 6)**.

In SA, total fiber intake was positively predicted by BMI. Total added sugar intake was positively predicted by education level. Total added sugar was negatively predicted by marital status and employment status. The percentage of recommended grain intake was positively predicted by age. The intake of the recommended SAT fat percentage was negatively predicted by BMI. The percentage of recommended of added sugar was negatively predicted by age, marital status, and employment status, however, positively predicted by the number of children (**Tables 5 and 6)**.

In the KR, energy intake positively predicted by age. The intake of total fat was positively predicted by age, and negatively predicted by employment status. Protein intake was negatively predicted by employment status. The intake of the recommended SAT fat percentage was positively predicted by age, and negatively predicted by BMI and employment status (**Tables 5 and 6)**.

Further analyses were conducted by using Student's t-tests based on marital status, employment status, and education levels. While there were no differences between married and single women in SA, Saudi married women in the US had significantly higher intakes of energy, carbohydrate, fat, and percentage of recommended fruit intake compared to single women in the US. Saudi married women in the US had significantly lower percentage of recommended added sugar intake than that of the single women in the US**.** Married women in KR had significantly lower protein and percent of recommended protein intake than that of single women in KR **(Table 7).**

Due to the low number of employed women in the US and low number of women with less than high school educations, t-tests were not conducted on the US sample for these two variables. In SA, employed women consumed significantly higher amount of fiber and percent of recommended dairy than that of unemployed women. The percent of recommended added sugar intake was significantly lower in employed than that consumed by unemployed women. In the KR, employed Saudi women consumed significantly less energy, total fiber, protein, fat, SAT, percent of recommended intakes of dairy, protein, SAT and sodium than unemployed women. Those with more than high school education had a significantly higher percentage of recommended fruit intake among Saudi women in SA. No differences in any intakes between education levels in women residing in KR **(Tables 8, and 9).**

Objective 2: To test the hypothesis that the length of time since emigrating from SA was associated with a larger divergence from traditional SA dietary pattern.

General linear model analyses (two-factor ANOVA) were conducted to test the association between country and years of residency abroad among Saudi women residing in the US and KR and nutrient intakes and percent of recommended intakes. As shown in **Table 10,** participants in the KR showed a significantly lower energy intake than those in the US. Furthermore, KR participants with longer length of residence had lower energy intake than those in SA. The energy intake was not significantly different in the US across the length of residing in the US, thus a significant country and years of residence interaction was observed. There was a statistically significant interaction between the years of residency and the host country on intakes of carbohydrate, total fiber, total soluble fiber, and total sugar. Those who newly arrived (<5 years) to the US consumed more carbohydrate than women in SA and maintained a higher amount of carbohydrate than women in SA as years of residency in the US increased. However, those participants in the KR showed a significantly lower carbohydrate intake as their residence in the KR was longer than five years. Those with residency of less than five years in the US consumed more fiber and sugar as years of residency increased, whereas in the KR they showed a significantly lower fiber and total sugar intakes with longer residency in KR. Therefore, significant interactions of country and length of residence were observed in carbohydrate, total fiber, total soluble fiber and total sugar intakes (**Table 10**).

As the length of residency abroad increased, participants in both the US and KR had higher intakes of cholesterol than women in SA (p=0.008). In the US, higher percentage of recommended fruit and vegetable intakes than women in SA was shown and the intake maintained higher than women in SA as years of residency increased. However, those participants in the KR showed a significant drop in fruit and vegetable intakes as their residence in the KR was longer than five year. Overall, participants in the US consumed higher percent of recommended fruits than those in the KR **(Table 10)**.

Student's tests were performed to compare the nutrient intakes of participants in SA and participants in the US or KR. One-sample t-tests were used to compare nutrient intakes of participants in the US or KR with the consumption of the US and KR general populations. This is to determine if the SA participants in the US and in KR consumed similar or different amount of nutrients as compared to the consumptions in the US and KR general populations. The general intake levels for women were obtained from previous studies that analyzed data from the NHANES 2015-2018 and Korea National Health and Nutrition Examination Survey (KNHANES) 1998-2015 (Moshfegh, 2021; Yun, Kim, & Oh, 2017). In order to demonstrate that acculturation occurred, the significant differences should be seen only between participants in the home country and the intakes in the host country, and the participants' intakes should be similar to those of the host country. **Tables 11 and 12** showed acculturation was observed only among Saudi in the KR in terms of energy intake as demonstrated by the fact the KR participants had significantly lower energy intake than that of the SA participants, but not different from that of the KR general population. There was no acculturation among Saudi in the US. SA women in the US consumed significantly more energy than that of the US general population, but it was not different from the energy intake by SA women in SA. Participants in the US consumed significantly more carbohydrate, total fiber, and total sugar than that of Saudi in SA and the US general population. Monounsaturated fatty acids (MUFA) and polyunsaturated fatty acids (PUFA) were significantly lower in Saudi in the US than the US general but not different from the MUFA and PUFA intakes in Saudi in SA. **(Table 11)**.

For Saudi in the KR, their energy intake was significantly lower than that of Saudi in SA but not different from the energy intake in the KR general population. Carbohydrate intake of Saudi in the KR was significantly lower than that of Saudi in SA and in the KR general population. SA women in the KR consumed significantly more fat than that of the KR general population, but it was not different from the fat intake by SA women in SA. **(Table 12)**.

Objective 3: To test the hypothesis that participants' BMI levels were different among the three countries, and that the health-related variables and percentage of recommended intakes were different among the BMI categories.

One-way ANOVA showed that there was no significant difference in BMI among the participants of the three countries **(Table 4)**. General linear model ANOVA analyses were conducted to identify the association between country, BMI and their interaction on percentage of nutrient recommendations. Within each country, none of the percentage of recommended intakes were significantly different among the BMI categories. However, when combining the three countries together, percentage of recommended SAT intake consumed was significantly higher among participants with normal BMI (p=0.02, **Figure**

1). No other nutrients or percent of recommended intakes showed any difference among the different BMI categories either within each country or in three country combined.

BMI Distribution

Chi-square analysis showed that the only variables that were significantly different according to BMI categories were age and self-reported health status (p=0.006 and p=0.02, respectively). In age category, all the underweight participants were younger than 33 years of age. More than half of the participants in this age group had normal weight. Close to one-third of the participants between ages of 34-49 were obese. Eighty percent of the older participants (older than 50 years) were obese **(Figure 2)**.

In self-reported health status, more than half of the participants reporting in excellent health status had normal BMI while no underweight participants fell under this category. Health status of underweight participants were reporting either fair or very good health status. Participants with normal and obese BMI comprised the majority of the very good health category. About 40% of the participants reported fair health category were overweight. The poor health category was equally-represented by normal, overweight, and obese participants with no underweights belong in this category **(Figure 3)**.

BMI and Chronic Diseases

Student's t-tests were used to test the difference in mean BMI between individuals with and without each chronic disease. When combining all three countries together, there was a significant difference in BMI between participants with and without most of the chronic diseases. Mean BMIs of participants with chronic diseases were significantly higher than those without chronic diseases**(Tables 13 and 14)**.

CHAPTER 5: DISCUSSION

The main goal of this research was to investigate food intakes and dietary patterns among Saudi women living in SA, KR, and the US. The dataset for this study was obtained from 24-hr dietary recalls pertinent to a previous study, and unlike SA and US data, the KR data were new and not included in the previous study (Alqahtani, 2017). The diet analyses of these recalls have not been performed before and were the focus of the current study. The breakdown of the 100 participants was as following: 48 residing in SA, 25 in the U.S., and 27 in the KR. The primary independent variable of interest was the length of residence in the host country, and it was categorized as either less than five years or more than five years. It was hypothesized that (1) the dietary patterns/nutrient intakes were different among the three groups of women; (2) the longer they left SA, the more likely their intake patterns were different from those newly arrived in the host countries and those who remained in SA; and (3) BMI levels were different among participants in the three countries, and that the health-related variables and percentage of recommended intakes would be different among the BMI categories.

OBJECTIVE 1: To test the hypothesis that the dietary patterns/nutrient intakes were different among the three groups of SA women residing in three countries.

The findings indicate that some dietary intake variables were different across participants in all three countries. More significantly, carbohydrates, total sugar, and fiber intakes were higher among Saudi women in the US in comparison to the Saudi in SA and Saudi in KR groups. One of the potential explanations is the high consumption of ready-to-eat and customary breakfast cereals among these US participants as shown in their dietary recalls. Breakfast cereals are typically rich in carbohydrate, total sugar, and fiber

(Priebe & McMonagle, 2016; Williams, 2014). Another contributor might be the high fruit intakes for the US participants as shown by the higher percent of recommended fruit intake by this group when compared with participants in SA and KR, since fruits are high in carbohydrates, fructose and fiber. A significant contributor to high sugar levels might also be the amount of soft drinks a society is consuming. For the US, soft drinks represent one-third of daily sugar intake (Huth, Fulgoni, Keast, Park, & Auestad, 2013). If we consider the low cost of and accessibility to soft drinks as well as breakfast cereals and milk, and most importantly, the elevated fruit intakes, Saudi women in the US could easily see their carbohydrate and sugar levels become significantly higher.

Additionally, given the tremendous psychological and social challenges associated with expatriating to a foreign country, Saudi women abroad could have resorted to palm date, a Saudi traditional food, as a form of a comfort food to maintain linkage to their original Saudi culture. In fact, based on dietary recalls, participants in this study reported high consumption of dates. Using food as a tool to maintain connection to one's native culture is common among immigrants. An example of this is provided by a study on Arabic and South Asian women immigrants to Canada which demonstrates how they utilized traditional foods from their home countries to keep feeling connected to their homes (Vallianatos & Raine, 2008). Saudi women in the US, therefore, could have consumed large amounts of date, either as a standalone snack intake or as a main ingredient to many other dishes, as means of identity maintenance as well as a nostalgic reaction to being distant from family and friends. Another study showed similar response among Latino individuals in New York where they identified traditional foods as a crucial approach in forming and maintaining their identities (Weller & Turkon, 2015). Consuming palm date provides a huge source of fiber and carbohydrates as date palm contain a high percentage of carbohydrate as a total sugar (as high as 88%) and a high percentage of dietary fiber (as high as 12%) (Al-Shahib & Marshall, 2003). Therefore, given that palm date is not a common component of US diet whereas it is a crucial part of Saudi diet, consuming palm date could be the differentiating reason behind high carbohydrate levels among Saudi women in the US in comparison to the carbohydrates consumed by the general US population as shown in Table 11. Furthermore, palm date is also reasonably available in the US through the US's own production of palm dates (Wright, 2006, 2016). Therefore, palm date consumption could have continued to play a role in shaping carbohydrate levels among Saudi women even after expatriating to the US by still being a crucial component of their everyday diet especially as a comfort food as mentioned earlier. Hence it is not hard to picture that palm date consumption between Saudi women in the US and Saudi women in SA are at least similar. However, given that our findings indicate that Saudi women in the US consumed more carbohydrate than participants in SA, additional factors such as higher fruit intake, and the popularity of cereal in the US as a breakfast choice, could have also played a role in those high carbohydrate intakes. As for the KR, dates are not similarly accessible or produced, and cereal is not as popular as it is in the US as a breakfast choice. This may contribute to the lower carbohydrate intake for SA participants in KR compared with that of US-residing participants or participants in SA.

This high consumption of date could also provide an explanation to the high sugar and fiber levels among those women in the US. Also, their percentage of recommended fruit intake as well as high education levels demonstrate further why sugar and fiber levels are high. Given the fact that education level acts as a positive predictor of fruit consumption as reflected by another study assessing adults' fruit intakes from What We Eat in America, National Health and Nutrition Examination from 2013 to 2016 (Martin, Hoy, Clemens, & Moshfegh, 2019), high fiber and sugar levels among those women could also be explained by their high education levels as there was only two participants in the US sample who had less than some college education. All of these factors could have influenced the high levels of carbohydrates, fiber, total sugar, and percentage of recommended fruit intakes among Saudi women in the US as compared to those in SA and KR.

The results of this study also showed that Saudi women in the US consumed significantly less junk food than Saudis in SA, although the overall differences in junk food consumption among participants in SA, US and KR did not reach significance. This is not surprising considering that consumption of junk food has been growing among Saudi adults in SA (Mandoura et al., 2017; Naeem, 2012). Because of the growing westernization of lifestyle and eating habits in SA, the trend of junk food consumption is expected to continue to rise, which would have significant effects on dietary patterns of Saudi adults. It may eventually lead to obesity-related chronic diseases (Al-Rethaiaa, Fahmy, & Al-Shwaiyat, 2010; Mandoura et al., 2017). While the same argument might have implied that Saudi women in the US could consume even more junk foods due to the wide range and accessibility, our data showed that they have actually consumed less than their counterparts in SA. One of the possible explanation to this could center on the halal requirement in Islamic religion. Muslims in non-Muslim countries pay very close attention to food offerings at restaurants and grocery stores. Their concern is to avoid pork-derived products like gelatin and products that contain alcohol. Also, they take the supply chain of desired products into consideration in terms of not being cross-contaminated by, stored with, or cooked alongside non-halal elements (Zulfakar, Anuar, & Ab Talib, 2014). Therefore, it is speculated that Saudi women could have cut back on their junk food consumption after arriving to the US as a precaution that the US candies, fast foods, or other junk foods are highly likely to contain pork or alcohol ingredients as observed by Zulfakar et al (2014). It is important to keep in mind the high availability of Arabic food and its accessibility in the US may have given those women an alternative that could have aided them in their endeavor to reduce junk food intake. Consuming more dates may have been one of the alternatives for junk food, resulting in more carbohydrate and fiber intakes as discussed previously. In the KR, however, this alternative could not have been enjoyed to a similar extent as that in the US because of low accessibility and limited Arabic food offerings in the KR as mentioned earlier. Therefore, while Saudi women in the KR could have also reduced their junk food intake due to halal requirements, their reduction levels were not as large as the US's, potentially due to absence of alternatives. As a result, we speculate that the two factors, halal food stipulations and availability of Arabic food alternatives, may have shaped the theme of junk food intake outside SA among Saudi women. The junk food consumption pattern in SA women residing in US cities without ample supplies of Arab foods deserves further investigation.

Despite the fact that consumption of grains is common in KR, our study found that Saudi women in the KR consumed significantly less energy, grains, carbohydrate, sugar, and added sugar than those participants in SA and the US. One possible explanation to this could be due to the dissimilarity and difference in taste between grains in KR and grains in SA. Rice is the major grain consumed by KR individuals. However, the rice in KR is cooked plain to go with their meat and fermented vegetable dishes. Rice dishes in SA, on the other hand, are mostly cooked along with halal meats and seasoned with special spices and ingredients. Finding foods in the host culture that are similar or close to that offered by one's original culture is an important determinant of his or her consumption pattern in the host country. A study on international students reported that they reacted adversely to local food options in host culture that were dissimilar to foods in their original culture in their home country (Brown, 2009). We speculate that the reaction of expatriates to the dissimilarity in foods could also be multiplied if they were to be residing at an ethnically-homogenous country such as the KR. At the present time, foreigners accounts for 4.9% of the KR population, below the 5% required to be considered as a multicultural country, therefore KR is still considered as a homogenous country with limited foreign influence (Yonhap news agency, 2020). Saudi women may have found the KR grains such as rice taste plain and different from the rice they used to eat in their home country and consumed less accordingly. Those low intakes of grains, carbohydrate, and sugar result in the low energy intake among Saudis in the KR as compared to Saudis in SA and the US. Additionally, SA women in the KR could have been pressured by Korean body standards where most KR women are slender (Y. Lee, 2017). This could have led SA women in the KR to eat less and try to lose weight. These shifts could also be due to the shortage of Arabic food supplies in the host countries, similar to the case when Chinese individuals showed similar shifts by changing their diet while abroad because of limited access to traditional Chinese foods (Lv & Cason, 2004).

Therefore, driving forces behind these changes could include similarity of food items in the host culture to those in the original culture, the availability and accessibility to Arab ethnic groceries and restaurants at host countries, body weight standard in the host countries, as well as the time constraint to cook and prepare traditional dishes (Lv & Cason, 2004; Pan et al., 1999; Satia et al., 2000).

According to our study, marital status was a positive predictor of percentage recommended dairy and SAT fat intake among Saudi women in the US. Also, marital status was a negative predictor of total added sugar and percentage of recommended added sugar among Saudi women in SA and the US. We found that married Saudi women had lower total added sugar and percentage of recommended added sugar intakes. On the other hand, married Saudi women had higher percentage recommended dairy and SAT fat. Further analyses revealed that the differences between married and single women were mostly observed among SA women residing in the US. While literature that demonstrates an association between marital status and carbohydrate intake is limited, an association between marital status and fat intake has been demonstrated. A previous study has shown that husbands contributed to increasing consumption of fat and meat by their wives (Worsley, 1988). Energy intake was also found to be higher among US married women based on analysis of data obtained from NHANES from 1988 to 1994 (Davis, Murphy, Neuhaus, Gee, & Quiroga, 2000). A possible reason could be the practice of dining out more frequently among married couples or sharing meals with their husbands more often during the day which could also translate into high intake of carbohydrates, fat, and energy. However, upon conducting further analysis, our data showed significant difference in the consumption of total fat between married and single SA in the US, but for the difference in percent of recommended SAT intake between married and single SA women in the US failed to reach significance. Hence the difference between married and single women in the US in total fat intake may not be entirely due to difference in meat intake. Unsaturated fat intake may also contributed to the difference in total fat intake. It is also possible that variation in consumption data or sample size not being large enough so a difference in the percent of recommended SAT intake failed to be significant. Our study also indicated that married Saudi women in the US had significantly higher percentage of recommended fruit intake than single women which is in agreement with a systematic review that showed that married people consumed more fruit and vegetables than singles due to partner support and eating patterns (Kamphuis et al., 2006).

Our data demonstrated that the percentage of recommended added sugar intake was higher among single Saudi women in the US as compared to those married women, an observation that is in line with what was reported previously that lack of social integration leads to higher intakes of sugars (Henriksen, Torsheim, & Thuen, 2014). Singlehood is a form of social isolation the same way that expatriation and being away from home country are for Saudi women. Therefore, when combining both factors, being single and an expatriate, we expect a multiplied effect of a greater sugar intakes among those women. That is, missing a social support system, single Saudi women in the US could have resorted to sweets or sugary foods to cope with loneliness. This is not unlikely considering that sugary items are identified as comfort foods as it was reported that more than half of popular comfort foods include snacks are high in sugar content (Wansink, Cheney, & Chan, 2003). While the social isolation element could have also been present among Saudi women in the KR, it is speculated that palm date could not have been used as a comfort food because it is not as readily available as it is in the US. As a result, the added sugar and fiber intakes among Saudi women in the KR were lower.

The percentage of recommended added sugar intake was also positively predicted by number of dependent children among Saudi women in SA. Parents' consumption habits are greatly affected by their children's dietary preferences. This was demonstrated by studies that found that parents' decision-making in terms of product choice takes into consideration of their children's food choices (Søndergaard & Edelenbos, 2007; Tami et al., 2012). Hence, it is likely that Saudi women in SA may have found that their children prefer food that is high in added sugar and shared that added sugar intake with their children. No such prediction was observed for participants in the US and KR. In addition to the fact that the US and KR sample sizes were smaller than that of the SA, other potential predictors should be explored in the future.

The role played by marital status among Saudi women in the KR was that married Saudi women in the KR had lower protein intakes. A possible explanation to this begins with an understanding that animal-derived foods are major sources of protein that require more preparation time as well as effort to find alternatives for non-halal food in the KR. Married Saudi women in the KR who have marital or parental responsibilities may have less time for cooking, as well as less time to find other halal alternatives to KR meat.

Our results indicate that percentage of recommended dairy was positively associated with age and marital status among Saudi in the US. As for marital status, married women in the US exhibited greater dairy intake than single individuals. This finding is different from a previous report indicating that there was no difference in dairy intake between married and single individuals (Woo et al., 1999). The higher dairy intake in our study sample in the US could be due to higher breakfast cereal intake in children as stated previously. Since breakfast cereals are usually consumed with milk, and families with children are more likely to consume cereals for breakfast, this may have resulted in higher dairy intake among these married women (especially those with children). Also, it is likely that these married women with children are of older ages comparing with single women, hence, we speculate that this is also a reason that age positively predicted dairy intake.

Education levels emerged in our findings as a positive predictor of added sugar intake among Saudis in SA, but negative predictor of the intakes of percentage recommended fruit and SAT fat among Saudis in the US. The predicted direction in our analysis disagreed with previous findings (Mayen, Marques-Vidal, Paccaud, Bovet, & Stringhini, 2014; Murayama, 2015; Zhao, Sun, & Su, 2020). It is speculated that among the US participants only two had education levels at high school or less. Hence, the significant prediction of education level for SAT intake should be interpreted with caution. Future studies to enroll more SA women in the US with less than high school education level (if possible) are warranted to explore this phenomena further.

Although the energy intake of Saudis in the KR appeared to be generally lower than those in the US and SA, our results observed that total energy, total fat, and percentage of recommended saturated fat intakes were positively associated with age among Saudis in the KR. This is opposite of what was reported by other studies that energy intake decreased among adults and more significantly among older participants (Marti-Henneberg et al., 1999; Otsuka et al., 2016). An explanation to this could be that these increases may not have been directly resulted from changes in consumption patterns by older adults but rather from decreasing intakes of younger adults as a measure to manage their body weight to stay fit. Indeed, when women younger than 30 years of age from these three countries were compared, SA women in KR (1530±180 kcal) consumed about 450 kcal less per day than women in the US (1949±184 kcal) and SA (1974±103 kcal), although the difference failed to reach significance. The implication here is that SA women in KR may have been influenced by their surroundings, therefore, reduced their energy intake in order to lose weight to look like their KR counterparts. This is especially true considering that younger adults are sensitive to their weight levels (Wardle, Haase, & Steptoe, 2006) which could entail attempts to reduce calorie intake and percentage of recommended saturated fat. This is also applicable to Korean women whose bodies are slender and have low BMI measures as reported in a previous study. Lee et al' analyzed data from 2008–2012 by the Korean National Health and Nutrition Examination Survey (KNHANES), and found that 52% of women participants had BMI levels less than 23 kg/m^2 (Y. Lee, 2017), while only 33.1% of the US women having BMI less than 24.9 kg/m^2 in 2013-2014 (National Institute of Diabetes and Digestive and Kidney Diseases, 2017). It is unclear why BMI was negatively associated with SAT fat intake among SA women in the KR, and deserves further investigation.

Overweight and obesity are even more prevalent among SA women in SA, with 72% of them are either overweight or obese in 2016 (Global Nutrition Report, 2021). It follows, then, that SA women in SA could have had even bigger concerns over their weights and, hence, attempted to control their diets by showing higher intake of grains and lower intake of percentage added sugar as they progressed with age. Another likely reflection of this is given by the fact that SA women in SA increased their fiber intake and reduced their saturated fat intake. These dieting attempts heed to scientific evidence that increasing fiber intake was inversely related to BMI levels (Van de Vijver, Van den Bosch, Van den Brandt, & Goldbohm, 2009), as well as to research observations that SAT fat intake is a high risk factor for obesity (Phillips et al., 2012). This idea should be considered cautiously, however, because our data on SA women in SA also showed a positive relationship between their BMI and fiber intake and a negative one between their BMI and SAT fat intake. The relationships among BMI, dietary fiber intake and SAT intake in SA women in SA are not yet clear and should be explored further.

Two distinctive patterns were observed with employment status. First, protein and percentage of recommended protein intake among Saudi women in the KR was inversely associated with the employment status – employed SA women in KR consumed less protein. Secondly, similar inverse relationship with employment was found with total added sugar and percentage of recommended added sugar among Saudi women in SA. To understand these patterns we must realize first that employment results in a higher income and a busier lifestyle, and would logically be associated with high level of education as well. Thus, to begin with, the negative relationship between employment and protein intake among Saudi women in the KR could have resulted because employed Saudi women have potentially consumed less animal-derived foods and meat, which are a major source of protein. This was possibly due to two main reasons: the long preparation times that these foods require and the scarcity of halal foods in KR. Unemployed women, comparatively, could overcome those two hurdles by having more free time to prepare foods and to look for or come up with alternatives for non-halal foods. Similarly, upon conducting further analysis on Saudi women in the KR, we have found that employment was significantly associated with lower intakes of fat, SAT fat, and energy. We speculate these could also be a result of low meat consumption among those women for the same reasons mentioned earlier, especially given that meats provide fat, SAT fat, and eventually, energy. Also, our analysis revealed that general KR population had lower protein intakes than our SA sample in SA. Unemployed SA in KR had significantly higher protein intakes (74.2±5.3 g) than the general KR population (61.4 g) while employed SA (46.8±6.3) in KR had protein intake similar to the general KR population. This gives a possible indication that, in addition to the above mentioned scenario, employment may also enhance acculturation among Saudi women in the KR. These employed women had the opportunity to interact with local people and be in an environment outside their home and therefore enhanced the acculturation process. Lastly, the negative association between employment and the consumption of added sugar among Saudi women in SA could again be related to education and nutritional awareness. That is, to be employed entails being educated at least in terms of awareness of healthy diet and its consequences on health and job performance. Therefore, highly educated Saudi women in SA could have been more selective and conscious of their sugar intakes and made an effort to keep them low or balanced (Murayama, 2015). There remains a scientific need for further research to validate these findings. How the education levels affect nutrient intakes for the SA women in the US could not be evaluated in this study due to the small number of participants in the US with lower than some college educations.

OBJECTIVE 2: To test the hypothesis that the length of time since emigrating from SA was associated with a larger divergence from traditional SA dietary pattern.

Saudi women in the US generally maintained higher carbohydrate consumptions as compared to those in SA, which is at odds with what was reported that South Asian and Asian immigrants to the US consumed less carbohydrates the longer they stayed in the US (Talegawkar, Kandula, Gadgil, Desai, & Kanaya, 2016; Yang & Read, 1996). The high carbohydrate consumption in the US seems to also be reflective of similar high sugar intakes among Saudi women in the US. Indeed, this pattern of progressively higher sugar intake through length of residency confirms what was reported that Chinese women consumed more sugar the longer they stayed in the US (Tseng, Wright, & Fang, 2015). Based on the nutritional link between carbohydrate and sugar, we should also consider the psychological factor that was a critical instigator behind high sugar intakes among Saudi women in the US as discussed earlier, to similarly explain their high carbohydrate consumption in the US as well. These women may have been emotionally overwhelmed with the new culture that they responded by purchasing and consuming higher levels of carbohydrate in comfort foods than the levels consumed at SA as well as the average intake in the US general population. Nostalgic and emotional reactions, and attempts to maintain connection to home may be results of this psychological cycle. This is especially evident by the fact that their carbohydrate intake was so much higher during their initial years in the US, which is a time period during which feelings of shock and attempts to settle down would be at their highest. Afterwards, this pattern started to decline but still remained higher than that observed in SA and in the US general population, the two populations that do not experience this psychological stress of moving to a new host country. Whether the carbohydrates or sugar consumption of SA women in the US will eventually approach the levels consumed by the US general population, and/or how long it will take if it does occur deserves further investigation.

The KR sample, on the other hand, showed the opposite from the US as Saudi women's carbohydrate and sugar intakes in the KR were lower than those observed in SA. This agrees with findings on Vietnamese women immigrants in the KR where their carbohydrate levels experienced declining trend throughout their residency in the KR (Hwang et al., 2014). While the psychological element was possibly still present which could have led to high carbohydrate and sugar levels, it may have been less defining than two other possible factors in influencing their intakes. The first factor would be that KR has less Arab minorities and less availability of Arabic grocery options, as established earlier, hence, Saudi women may have progressively consumed less carbohydrates or sugar over the years in response to either unavailability, such as dates, or lack of resemblance of offerings in KR to those in SA. The second factor could be that BMI levels in KR showed decreasing trend among KR women in recent years (Khang & Yun, 2010). SA women in the KR may have been influenced by what they perceived as desirable for being skinny in KR and made an effort to lose weight as stated previously. It should be noted that there were only three SA women stayed in KR for more than five years. However, even without counting these three participants, the decline in carbohydrate intake was still apparent for those stayed in KR for less than five years, and an interaction of years of residency and host country (US vs KR) was observed. The downward trends of carbohydrates and sugar consumptions with the increase in duration of residency in KR deserve to be investigated with a large sample size and for longer than five years.

Total cholesterol intakes were not different among the three groups. Nevertheless, cholesterol consumption among Saudi women in the US and KR followed an increasing pattern throughout their stay, similar to what was experienced by Asian Indians in the US (Talegawkar et al., 2016). There is not much literature that investigates dietary patterns of immigrants in KR over time. The reasons behind this increasing trend are unclear which necessitates further studies to confirm our findings. These high cholesterol intakes may increase the likelihood of developing disease conditions such as cardiovascular diseases, hypertension, or obesity among Saudis who already have high prevalence of chronic diseases (Aljefree & Ahmed, 2015; AlQuaiz et al., 2014).

The percentage of recommended fruit intakes among Saudi women in the US was generally higher with longer residency. Lv and Cason (2004) reported an association between longer length of residency in the US by Chinese Americans and a greater increase in their consumption of fruit (Lv & Cason, 2004). The incremental pattern of fruit intake among Saudi women in the US could be driven by the wide availability of fruit in US grocery stores and supermarkets. In SA, those women may not have enjoyed such wide availability of fruit and vegetable as SA does not have high production of fruit and vegetable apart from dates due to climate factors (El Bcheraoui et al., 2015). In the US, the sustainable supply of fruit is a result of the US active participation in international trade agreements and its influential role in the fruit global market (Huang, 2004) which ensures both constant foreign and domestic offerings of fruit in the US. In fact, it has been reported that the US Free Trade Agreements have ensured a year-round availability of fruits to US consumers (Huang, 2004; Knutson et al., 2014). Thus, Saudi women in the US could have increased their intake of fruit in response to higher availability and supply. As for the

KR, the intake pattern of fruit for Saudi women was generally declining which agrees with the pattern exhibited by Chinese international students in the KR (Gao & Kim, 2018; J. Lee, Gao, & Kim, 2015). The availability argument could also be applied to the KR case where production of fruit is very vulnerable to weather conditions. In recent years, drought and water insufficiency in the KR have been affecting the agricultural sector and farm production as well as food prices tremendously (Nam et al., 2018). Saudi women in KR may have decreased their fruit intakes in response to both low availability and high pricing, but this speculation requires further investigation.

Our observations on fruit and vegetables intakes also reflect fiber intake levels among Saudi women. SA women in the US had higher fiber levels possibly due to higher fruit and vegetable intake, whereas in the KR their intake was possibly low in response to low fruit consumption. Our US observations could not be benchmarked against other studies due to limited literature that analyzed length of residency and fiber intake among immigrants. On the other hand, our findings on Saudi women's fiber intake in the KR are similar to what was observed on Vietnamese woman immigrants to the KR in Hwang et al's study. That study reported that as the length of residency in KR increased, the consumption of fruits and vegetables were reduced. Hwang et al explained that this reduction was due to the KR's unavailability of the types of vegetables and fruit that are preferred by Vietnamese such as swamp cabbage, yam, papaya, longan, and guava, which eventually reduced dietary fiber intake (Hwang et al., 2014).

All previously-mentioned changes in dietary intakes among Saudi women over their years of stay at host countries could demonstrate the integration aspect of acculturation. According to the participants' dietary recalls, they may have exhibited some bicultural responses of adopting host countries' foods such as pizza in the US but maintaining traditional foods such as palm date. This is similar to what was found by Aljaroudi et al: over their years of stay, Muslim women immigrants to Canada undertook dietary behavior changes and consumptions of foods from their host culture, while also maintaining their traditional food intakes, which demonstrates a biculturalism phenomenon (Aljaroudi et al., 2019). SA women in the US could exhibit the biculturalism, but SA women in the KR may not be able to exhibit this due to limited Arab grocery stores or restaurants. Thus, acculturation is more likely in KR, but not in the US, due to differing availability of and accessibility to Arab food in the two countries. These findings are further supported by a symmetric review which highlighted that the limited studies in this regard support transitions in dietary habits by immigrants despite attempts to maintain traditional diet (Sanou et al., 2014).

There were no clear indications of acculturation among Saudi participants in the US. It is speculated that their diets were already highly westernized in their home country (Musaiger, 2014), thus transitioning into US diet resulted in not much of a difference. On the other hand, Saudis in KR were introduced to a diet pattern that was very different than their home country. Combined with the limited availability of Arab food items in KR, these factors could explain why some acculturation signs showed in KR sample regarding energy intake, and protein intake in employed participants. It was reported that KR women's energy intake remained at 1,754 kcal for nearly two decades (Yun et al., 2017). The energy intake of Saudi women in the KR were similar to those levels at 1681 kcal, showing a significant reduction compared to the energy intakes of SA women in SA. This indicates that some of the Saudi women's dietary intake has approached the level of KR dietary intakes, a similar response to that exhibited by Vietnamese immigrants in the KR. In particular, those Vietnamese women showed additional reductions in their energy intake as showed by a follow up study few years later (Hwang et al., 2014). Whether SA women in KR will further reduce their energy intake as their stay in KR lengthens, as shown in Vietnamese women, is still not yet known and deserves further investigation to depict their acculturation process in KR.

Combining our current results and those reported by Hwang et al (Hwang et al., 2014), there is evidence that greater differences in dietary patterns between the home and host countries increase the likelihood that acculturation will occur. When the home country's diet patterns are already similar to that of the host country, diet acculturation may not be easily identified.

It should be noted that no acculturation questionnaires was administered to the participants in the US and KR. Administering a questionnaire assessing the degree of acculturation, such as the one developed by Barry (2005), and examining the association between degree of acculturation and dietary pattern changes would provide more definitive information regarding the relationships between length of residency in host countries and dietary pattern/nutrient intake changes (Barry, 2005)

OBJECTIVE 3: To test the hypothesis that participants' BMI levels were different among participants in the three countries, and that the health-related parameters and percentage of recommended intakes were different among the BMI categories.

BMIs of SA women residing in the three countries were not different from each other and all in the overweight range. BMI distribution in this study showed that the percentage of obesity was highest among those older than 50 years of age (80%) with the second highest being those of 34-49 years old (50%). Other study also found a significantly increasing trend of obesity with advancing age, the highest being among those of 40–59 years than among younger adults (Hales, Carroll, Fryar, & Ogden, 2017). While we did not measure basic metabolic rate and physical activity levels in these women, higher energy intake in older participants as observed in the current study could have partially contributed to the increasing trend of BMI with age.

Our results show that self-rated “excellent health” status was higher among participants with normal BMI (60%) whereas the lowest status was among those at the obese weight category (10%). Similarly, other studies with subjects who were obese were less likely to report superior health statuses, a category that corresponds to the “excellent health” status in our study (Cai, Coyte, & Zhao, 2017). This is not unexpected as obesity is a significant risk factor for chronic diseases. In line with other studies (Kearns, Dee, Fitzgerald, Doherty, & Perry, 2014; Okpala, 2014), our results showed that mean BMIs of participants with majority of the chronic diseases were significantly higher than those without chronic diseases. This may explain why obese participants reported lower self-reported health status. To better understand the obesity problem, it is worth noting that 28 fewer cases of chronic diseases would result from just a one unit decrease in BMI among 1,000 women (Kearns et al., 2014). Thus, even a slight reduction in BMI will have significant public health implications.

Participants with normal BMI showed the highest percentage of recommended intake of SAT fat. This was not what we have expected. The high intakes of SAT fat may increase the likelihood of cardiovascular diseases by increasing low-density lipoprotein cholesterol (Mensink, 2016). It may also jeopardize their “normal weight” status and may lead to obesity (Bahadoran, Mirmiran, & Azizi, 2015). Further studies are needed in this regard to investigate the reason that normal-weight participants consumed more SAT fat than participants in other BMI categories. Any dietary intervention should aim at these participants currently with normal BMI in order to prevent the development of obesity in the near future.

CHAPTER 6: STRENGTHS, LIMITATIONS, and FUTURE DIRECTIONS

Dietary intakes of Saudi women were analyzed to provide a deeper understanding of their dietary pattern in three different countries. The major strength of this study is the diversity of the sample that covered two host countries and each with its own unique dietary habits. This gives us an opportunity for broad examination and comparisons of changing in dietary patterns and for investigation of the extent of dietary acculturation among SA immigrants. Considering the fact that more Arab individuals are relocating to foreign countries and the limited literature on both Saudi women and their acculturation processes in host countries, our study will be useful in aiding future research to evaluate dietary acculturation and health in Arab populations.

However, there were some limitations in this study. Dietary 24-hour recall data may not be a long-term representation of dietary patterns of the participants. In addition, there is scarce English literature that focuses on dietary acculturation in the KR. This made it difficult to compare our results to other studies. From the previous larger study, only data collected from participants from SA were used in this study. This resulted in a smaller sample size for this study. Therefore, replicating our study on a larger population is warranted. Also, in the previous study, water was not reported as part of beverages and it should be added to the food recall records. Only females were recruited in the previous study based on the fact that women in Arab countries are responsible for food preparation more than men. Most of our sample were students and young, hence, future studies that would include non-students are encouraged. Also, in terms of education level and employment status, our study included only two participants in the US who had high school education or less, and only one participant in the US who is employed. Therefore, future studies are needed that expand the recruitment to include more participants with high school or less education level as well as more employed participants.

The current study is a cross-sectional study which resulted in a smaller sample size, and was not able to capture change over time. It may be vulnerable to having confounding variables. Additionally, instruments to measure acculturation were not used. Ideally, a longitudinal study following the same group of immigrants for a prolonged period of time and periodically administering acculturation questionnaires would help in revealing the relationships between acculturation and dietary changes over different timeframes.

Furthermore, all the US participants were recruited in a large metropolitan area of a major US city with a large Arab population. There were plenty of Arab grocery stores and restaurants. This may make acculturation patterns differ from other SA immigrants residing in smaller cities or in cities without readily available or accessible Arab grocery stores and/or restaurants. Therefore, generalization of current findings to other Arab samples deserves caution.

For future directions, more research is needed in these areas: recruiting larger sample sizes, including male gender, and using a longitudinal design with long-term follow-up. In particular, we recommend including Saudi men and following these men and women for more than five years in the host countries in order to examine dietary acculturation and its effects on the development of chronic diseases in these expatriates.

CHAPTER 7: CONCLUSION

Informative findings were observed in this study revealing some differences in dietary intakes among Saudi women residing abroad or in their home country. Our analyses showed different observations such as increase intakes of fruit and vegetable in the US but reduced energy intakes in the KR. Increased intakes of unhealthy foods such as those high in cholesterol in the US and KR were also observed. Dietary acculturation more likely occurs in countries with distinct culture and not having enough food items from home countries. Preemptive strategies to promote cultural sensitivity and encourage positive dietary behavior are needed among immigrants. By adopting ways to reduce the consumption of sugar and convenience foods and increase healthy choices, immigrants may not become a burden to the health systems of host countries.

Table 1: Participants' demographic characteristics

Characteristics	Categories	All n (%)	SA n (%)	US n (%)	KR n (%)
Age (years)	Range	18–65	18-65	22-58	18-52
	Mean±SD	32.5±9	32.1±10.1	32±7.4	33.9±8.4
Age Category	≤ 33	60 (60)	31 (64.6)	16 (64)	13 (48.1)
	34-49	35 (35)	14 (29.2)	8 (32)	13 (48.1)
	>50-60	5 (5)	3 (6.3)	1 (4)	1 (3.7)
Residency at time of sampling	Saudi in US	25 (25)			
	Saudi in SA	48 (48)			
	Saudi in KR	27 (27)			
Number of years in the US	< 5 years	18 (72)		18 (72)	
	> 5 years	7 (28)		7 (28)	
Number of years in South Korea	< 5 years	24 (88.9)			24 (88.9)
	> 5 years	3 (11.1)			3 (11.1)
Education Level	Primary school graduate	2 (2)	2 (4.2)	0 (0)	0 (0)
	Middle school graduate	4 (4)	4 (8.3)	0 (0)	0 (0)
	High school graduate	19 (19)	11 (22.9)	2 (8)	6 (22.2)
	Some college	19 (19)	10 (20.8)	1 (4)	8 (26.9)
	College graduate	31 (31)	14 (29.2)	8 (32)	9 (33.3)
	Graduate/professional Degree	25 (25)	7 (14.6)	14 (56)	4 (14.8)
Occupation	Homemaker	25 (25)	12 (25.0)	3 (12)	10 (37)
	Student	43 (43)	9 (18.8)	21 (84)	13 (48.1)
	Teacher	9 (9)	8 (16.7)	0 (0)	1 (3.7)
	Other	18 (18)	15 (31.3)	1 (4)	2 (7.4)
	missing	5 (5)	4 (8.3)	0 (0)	1 (3.7)
Employment Status	Employed	35 (35)	27 (56.3)	1 (4)	7 (25.9)
	Unemployed	65 (65)	21 (43.8)	24 (96)	20 (74.1)
Marital Status	Single	42 (42)	26 (54.2)	7 (28)	9 (33.3)
	Married	58 (58)	22 (45.8)	18 (72)	18 (66.7)
Do You Live Alone	Yes	12 (12)	2 (4.2)	4 (16)	6 (22.2)
	No	88 (88)	46 (95.8)	21 (84)	21 (77.8)

People live in the house	Mean±SD	3.5±2.5	4.4±2.6	2.6±1.9	2.8±2.2
House hold Number	Alone	12 (12)	4 (8.3)	4 (16)	6 (22.2)
	1-4	51 (51)	22 (45.8)	16 (64)	13 (48.1)
	5-8	31 (31)	18 (37.5)	5 (20)	8 (29.6)
	9-12	4 (4)	4 (8.3)	0 (0)	0 (0)
	Missing	2 (2)		0 (0)	0 (0)
Are You A Parent	Yes	55 (55)	24 (50)	14 (56)	17 (63)
	No	45 (45)	24 (50)	11 (44)	10 (37)
Number of children	Mean±SD	1.5±1.8	1.5±2.0	1.2±1.5	1.9±1.8
Number of dependent children	Mean±SD	1.2±1.5	2.5±0.8	1.0±.4	1.7±1.6
Age of dependent children (years)	< 1	51 (51)	28 (58.3)	13 (52)	10 (37)
	1-2	26 (26)	12 (25)	6 (24)	8 (29.6)
	3-4	18 (18)	6 (12.5)	4 (16)	8 (29.6)
	5-6	2 (2)	1 (2.1)	0 (0)	1 (3.7)
	Missing	3 (3)	1 (2.1)	2 (8)	0 (0)
Race	White	62 (62)	24 (50)	15 (60)	23 (85.2)
	Black	2 (2)	1 (2.1)	1 (4)	0 (0)
	Asian	4 (4)	0 (0)	4 (16)	0 (0)
	2 or more	5 (5)	2 (4.2)	1 (4)	2 (7.2)
	None of these	20 (20)	16 (33.3)	4 (16)	0 (0)
	Missing	7 (7)	5 (10.4)	0 (0)	2 (7.2)

Table 2: Anthropometric measures, BMI and self-rated health of the participants

	Category	Mean±SEM or n (%)			
		All	**SA**	**US**	**KR**
Weight (lbs)	Mean±SEM	144.6±3.3	141.7±8.7	145.8±6.8	148.8±0.06
Height (ft)	Mean±SEM	5.2±0.02	5.2±0.03	5.3±0.06	5.3±0.04
BMI (Kg/m^2)	Mean±SEM	26.2±0.6	25.8±1.0	26.7±1.1	26.4±0.7
BMI Category	< 18.5	5 (5)	4 (8.3)	1 (4)	0 (0)
	18.5-24.9	46 (46)	24 (50.0)	10 (40)	12 (44.4)
	25-29.9	28 (28)	10 (20.8)	8 (32)	10 (37.0)
	>30	21 (21)	10 (20.8)	6 (24)	5 (18.5)
Self-Rated Health	Excellent	48 (48)	17 (35.4)	11 (44)	20 (74.1)
	Very good	39 (39)	24 (50.0)	9 (36)	6 (22.2)
	Fair	10 (10)	6 (12.5)	4 (16)	0 (0)
	Poor	3 (3)	1 (2.1)	1 (4)	1 (3.7)

Table 3: Participants' health-related characteristics

Characteristics	Categories	n (%)	Mean ± SEM
Health Insurance	Yes	63 (63)	
	No	37 (37)	
Smoking Status	Yes, previous smoker	8 (8)	
	Current smoker	10 (10)	
	Never smoker	82 (82)	
Exercise Hard (time/week)	0	73 (73)	
	1	7 (7)	
	2	10 (10)	
	3	5 (5)	
	4	1 (1)	
	5	1 (1)	
	7	2 (2)	
	Missing	1 (1)	
Hours of exercising hard (hour/day)	Mean±SEM		0.2 ± 0.04
Exercise Moderately (time/week)	0	10 (10)	
	1	5 (5)	
	2	21 (21)	
	3	15 (15)	
	4	11 (11)	
	5	14 (14)	
	6	4 (4)	
	7	17 (17)	
	> 7	1 (1)	
	Missing	2 (2)	
Hours of exercising Moderately (hour/day)	Mean±SEM		1 ± 0.1
Walking (time/week)	0	16 (16)	
	1	10 (10)	
	2	29 (29)	
	3	18 (18)	
	4	7 (7)	
	5	10 (10)	
	6	1 (1)	

	7	6 (6)	
	Missing	3 (3)	
Hours of walking (hour/day)	Mean±SEM		0.8 ± 0.1
Hours of sitting (hour/day)	Mean±SEM		4.5 ± 0.4
High Blood Pressure	Yes	12 (12)	
	No	88 (88)	
Heart Disease	Yes	2 (2)	
	No	98 (98)	
High Cholesterol	Yes	15 (15)	
	No	85 (85)	
Sleep Apnea	Yes	4 (4)	
	No	96 (96)	
Asthma	Yes	3 (3)	
	No	97 (97)	
Allergies	Yes	25 (25)	
	No	75 (75)	
Diabetes	Yes	6 (6)	
	No	94 (94)	
Arthritis	Yes	8 (8)	
	No	92 (92)	
Muscles Tendons	Yes	5 (5)	
	No	95 (95)	
Skin Problem	Yes	11 (11)	
	No	89 (89)	
Ear Nose Throat Problems	Yes	8 (8)	
	No	92 (92)	
Cancer	Yes	1 (1)	
	No	99 (99)	
Renal Problem	Yes	2 (2)	

	No	98 (98)
Dental problems	Yes	14 (14)
	No	86 (86)
Others	Yes	4 (4)
	No	96 (96)
Meals (time/day)	1-1.9	25 (25)
	2-3	52 (52)
	> 3	21 (21)
	Don't know	11 (1)
	Missing	1 (1)
Junk Food (time/week)	0	3 (3)
	1-1.9	37 (37)
	2-3	26 (26)
	> 3	31 (31)
	Don't know	3 (3)
Grocery expenditure ($USD/Week)	$16-35	4 (4)
	$36-55	8 (8)
	$56-75	6 (6)
	$76-95	5 (5)
	> $96	29 (29)
Grocery expenditure ($SAR/Week)	$10-15	1 (1)
	$36-55	4 (4)
	$56-75	5 (5)
	$76-95	2 (2)
	> $96	35 (35)
	Missing	1 (1)

Table 4: Comparisons of the dietary intake among Saudi women in the US, in Saudi Arabia, and in South Korea (mean±SEM)

Dependent variable	In Saudi Arabia (n=48)	In the US (n=25)	In South Korea (n=27)	P
Total energy (kcal)	**1995±72[a]**	**2162±144[a]**	**1681±96[b]**	**0.008**
Energy from fat (kcal)	727±31	726±51	654±53	0.42
Energy from SAT (kcal)	252±14	231±20	210±21	0.23
Protein intake (g)	76±3	73±5	67±5	0.28
Carbohydrate intake (g)	**246±10[a]**	**296±23[b]**	**194±12[c]**	**<0.001**
Total fiber intake (g)	**18±1[a]**	**24±3[b]**	**16±1[a]**	**0.003**
Total soluble fiber intake (g)	**0.61±0[a]**	**1.25±0[b]**	**0±0[a]**	**<0.001**
Sugar (g)	**87±6[a]**	**123±14[b]**	**69±6[a]**	**<0.001**
Added sugar (g)	**32±3[a]**	**26±5[ab]**	**18±4[b]**	**0.043**
Monosaccharide intake (g)	**3±1[a]**	**12±3[b]**	**4±1[a]**	**<0.001**
Disaccharides intake (g)	**2±0[a]**	**7±2[b]**	**1±0[a]**	**<0.001**
Oligosaccharide intake (g)	**130±6[a]**	**127±9[a]**	**95±7[b]**	**0.003**
Fat intake (g)	81±3	81±6	73±6	0.42
Saturated fat intake (g)	28±2	26±2	23±2	0.23
Monounsaturated fat (g)	18±1	17±2	16±2	0.56
Polyunsaturated fat (g)	11±1	11±1	10±1	0.59
Trans fat intake (g)	0.3±0.1	0.2±0.1	0.5±0.1	0.30
Cholesterol intake (g)	246.7±16.3	278.9±26.1	298.7±32.2	0.25
Vitamin A – RAE intake (μg)	**313±27.3[a]**	**397±51.8[ab]**	**708±181.5[b]**	**0.008**
Caroten intake (mcg)	**62.1±12.6[a]**	**164.7±40.7[ab]**	**214.2±54.1[b]**	**0.003**
Retinol intake (mcg)	177±14.1	209±33.6	422±168.4	0.09
Beta carotene (mcg)	1308±247	1799±334	2562±657	0.08
Vitamin B1 intake (mg)	**1.2±0.1[a]**	**1.1±0.1[a]**	**0.8±0.1[b]**	**<0.01**
Vitamin B2 intake (mg)	1.2±0.1	1.2±0.1	1.1±0.1	0.75
Vitamin B3 intake (mg)	**18.5±1.2[a]**	**15.8±1.6[ab]**	**11.7±1.5[b]**	**0.003**
Vitamin B6 intake (mg)	**1.3±0.1[a]**	**1.3±0.2[ab]**	**0.9±0.1[b]**	**0.038**
Vitamin B12 intake (mcg)	2.8±0.3	2.6±0.3	5.3±1.9	0.12
Vitamin C intake (mg)	**58.7±6.8[a]**	**121.2±17.2[b]**	**80.8±9.6[a]**	**<0.01**
Biotin (μg)	5.3±1.3	8.5±1.2	5.0±1.4	0.18
Vitamin D-mcg (μg)	3.2±0.5	2.7±0.4	2.1±0.3	0.23
Vitamin E-α-Tocopherol (mg)	4.4±0.3	4.2±0.5	4.2±0.5	0.92
Folate (μg)	279±16.7	306±21.7	274±28.2	0.59
Vitamin K intake (mcg)	**80±13.1[a]**	**91.3±19.9[ab]**	**159.1±35.6[b]**	**0.030**
Pantothenic acid intake (mg)	**1±0.1[a]**	**1.5±0.2[b]**	**0.9±0.2[a]**	**0.041**
Fluoride intake (mg)	**0.06±0.01[a]**	**0.17±0.04[b]**	**0.10±0.02[ab]**	**0.005**
Calcium (mg)	722±45.1	742±55	622±71.6	0.33
Copper (mg)	0.8±0.1	0.8±0.1	0.9±0.2	0.76
Iron intake (mg)	**10.9±0.5[a]**	**13.3±0.9[b]**	**9.8±0.7[a]**	**0.006**
Magnesium intake (mg)	**199±10.6[a]**	**189±21.1[ab]**	**145±14.9[b]**	**0.026**
Manganese intake (mg)	**0.7±0.1[a]**	**1.3±0.2[b]**	**0.7±0.1[a]**	**0.002**

Phosphate (mg)	860±43.6	1006±312.6	618±56.6	0.22
Potassium (mg)	1797±96.5	1953±209.1	1460±125.1	0.06
Selenium (μg)	**81.9±5.1[a]**	**79.8±9.0[ab]**	**59.8±7.2[b]**	**0.05**
Sodium intake (mg)	3099±153	3384±240	3082±181	0.50
Zinc intake (mg)	**6.6±0.4[a]**	**5.2±0.5[ab]**	**4.9±0.7[b]**	**0.03**
Omega 3 intake (g)	0.9±0.1	0.8±0.1	0.8±0.1	0.35
Omega 6 intake (g)	8.0±0.7	5.8±0.9	6.9±0.9	0.16
Caffeine intake (mg)	86.6±7.7	80.2±11.1	74.4±10.6	0.64
Choline intake (mg)	186±11.9	193±20.3	184±22	0.94
Recommended grain (%)	**94.7±4.7[a]**	**96.8±10.5[a]**	**74.7±6.3[b]**	**0.06**
Recommended Vegetable (%)	54.6±5.7	72.1±12.2	76.7±9.2	0.11
Recommended fruit (%)	**37.7±9.2[a]**	**99.7±21.6[b]**	**32.7±9.4[a]**	**0.001**
Recommended Dairy (%)	48.9±5	45.6±5.9	39.5±7.1	0.52
Recommended protein (%)	98.2±7.2	84.5±10.1	87.9±9.7	0.48
Recommended SAT (%)	132±7.5	120±11.7	108±11.2	0.19
Recommended added sugar (%)	63.0±5.5[a]	50.1±8.1[ab]	41.3±9.7[b]	0.095
Recommended sodium (%)	135±6.6	155±13.1	134±7.9	0.22
Junk food (times/week)	2.1±0.1[a]	1.6±0.2[b]	1.9±0.2[ab]	0.09

Note:
Bold numbers indicated that there was a significant difference among the groups.
SAT: Saturated fats
Numbers with different superscripts are significantly different from each other at $p<0.05$, $p<0.01$, $p<0.001$
One way ANOVA and Post-Hoc Tukey's tests were performed.

Table 5: The association between demographic and dietary variables

	US			SA			KR		
	B (95% CI)	R^2	p	B (95% CI)	R^2	p	B (95% CI)	R^2	p
Total energy		.28	.49		.04	.94		**.52**	**.028**
Age	16.6 (-45.5, 78.7)		.58	11.0 (-10.8, 32.9)		.31	**46.6 (11.8, 81.4)**		**.01**
Number of years residence	110 (-649, 870)		.76				-161 (-797, 474)		.60
BMI	-26.9 (-102, 47.9)		.46	-.8 (-25.1, 23.5)		.95	-36.0 (-90.7, 18.7)		.19
Marital status	330 (-545, 1207)		.44	1.5 (-363, 366)		.99	-457 (-1010, 96.7)		.10
# children	163 (-196, 522)		.35	-33.5 (-155, 88.0)		.58	-131 (-309, 48)		.14
Edu levels	-619 (-1888, 650)		.32	-96.1 (-476, 284)		.61	-400 (-842, 42.4)		.07
Employ status	65.1 (-1766, 1896)		.94	68.1 (-298, 434)		.71	-380 (-795, 34.6)		.07
Total fat intake		.38	.23		.13	.44		**.43**	**.01**
Age	.25 (-2.0, 2.5)		.82	.97 (-.05, 2.0)		.06	**3.3 (1.3, 5.3)**		**.002**
Number of years residence	7.7 (-20.2, 36.5)		.57				-10.3 (-46.8, 26.3)		.56
BMI	-1.7 (-4.4, 1.1)		.22	.20 (-.9, 1.3)		.73	-2.3 (-5.5, 0.8)		.14
Marital status	21.0 (-11.2, 53.2)		.19	3.3 (-13.6, 20.2)		.69	-26.8 (-58.6, 5.1)		.10
# children	6.9 (-6.3, 20.1)		.28	-2.4 (-8.1, 3.2)		.39	-7.7 (-18.0, 2.6)		.13
Edu levels	-30.9 (-77.6, 15.7)		.18	-3.2 (-20.8, 14.5)		.72	-20.9 (-46.3, 4.6)		.10
Employ status	5.6 (-61.6, 72.9)		.86	3.0 (-14.0, 20.0)		.72	**-25.5 (-49.4, -1.6)**		**.04**
Protein intake		.23	.66					**.54**	**.02**
Age	1.0 (-1.2, 3.1)		.34	.14 (-.8, 1.1)		.78	.23 (-1.5, 1.9)		.78
Number of years residence	10.6 (-15.7, 36.9)		.41				4.5 (-26.7, 35.8)		.77
BMI	-.80 (-3.4, 1.8)		.52	-.53 (-1.6, .6)		.34	-.49 (-3.2, 2.2)		.71
Marital status	22.3 (-8.0, 52.7)		.14	.35 (-16.0, 16.7)		.97	-22.4 (-49.7, 4.8)		.10
# children	-7.5 (-13.2, 11.7)		.90	.90 (-4.6, 6.4)		.74	-2.7 (-11.5, 6.0)		.52
Edu levels	-1.0 (-44.9, 42.9)		.96	-.57 (-17.7, 16.5)		.95	-1.5 (-23.2, 20.3)		.89
Employ status	9.3 (-65.0, 72.7)		.76	8.2 (-8.2, 24.6)		.32	**-32.7 (-53.1, -12.3)**		**.003**
Total Carbohydrate		.27	.53		.02	.99		.23	.59
Age	3.6 (-6.2, 13.4)		.49	.47 (-2.6, 3.6)		.76	4.1 (-1.4, 9.5)		.13
Years of residency	-1.4 (-121, 118)		.98				-26.0 (-126, 73.5)		.59
BMI	-1.7 (-13.5, 10.1)		.76	-.17 (-3.6, 3.3)		.92	-3.2 (-11.7, 5.4)		.45
Marital status	14.0 (-124, 152)		.83	-6.8 (-58.6, 45.0)		.79	-32.0 (-119, 54.8)		.45
Number of dependent children	24.1 (-32.4, 80.6)		.38	-3.2 (-20.4, 14.1)		.71	-12.3 (-40.3, 15.7)		.37

Edu levels	**-106 (-306, 93.2)**		**.28**	**-12.5 (-66.6, 41.6)**		**.64**	**-52.7 (-122, 16.6)**		**.13**
Employ status	11.4 (-277, 299)		.94	5.0 (-47.0, 57.0)		.85	-7.7 (-72.7, 57.3)		.81
Total fiber		.28	.49		**.30**	**.02**		.37	.20
Age	.56 (-.58, 1.7)		.32	.09 (-.15, .33)		.45	.43 (-.14, .99)		.13
Years of residency	6.3 (-7.6, 20.2)		.35				-3.9 (-14.2, 6.5)		.44
BMI	.58 (-.79, 2.0)		.38	**.27 (.00, .53)**		**.05**	-.02 (-.91, .87)		.96
Marital status	10.0 (-6.1, 26.0)		.21	2.3 (-1.7, 6.3)		.06	1.6 (-7.4, 10.7)		.71
Number of dependent children	-3.0 (-9.6, 3.6)		.35	-.66 (-2.0, .67)		.32	-1.7 (-4.7, 1.2)		.23
Edu levels	-13.8 (-37.0, 9.5)		.23	-3.5 (-7.7, .6)		.09	-2.5 (-9.7, 4.7)		.48
Employ status	7.8 (-31.8, 35.3)		.91	5.5 (1.5, 9.5)		.008	-4.6 (-11.4, 2.2)		.17
Total sugar		.42	.16		.18	.21		.17	.78
Age	2.3 (-2.9, 7.6)		.36	.28 (-1.3, 1.9)		.73	1.9 (-1.2, 5.0)		.20
Years of residency	18.0 (-46.2, 82.1)		.56				-15.3 (-71.9, 41.3)		.58
BMI	1.7 (-4.6, 8.1)		.57	-1.4 (-3.2, .41)		.13	-3.6 (-8.5, 1.3)		.14
Marital status	-15.1 (-89.1, 58.9)		.67	-12.0 (-38.9, 14.9)		.37	6.4 (-42.9, 55.7)		.79
Number of dependent children	17.4 (-12.9, 47.7)		.24	1.7 (-7.2, 10.7)		.70	-5.8 (-21.7, 10.1)		.46
Edu levels	-82.2 (-189, 25.0)		.12	**29.6 (1.4, 57.7)**		**.04**	-12.9 (-52.3, 26.5)		.50
Employ status	-.02 (-155, 155)		1.0	-25.2 (-52.3, 1.9)		.07	-6.0 (-42.9, 31.0)		.74
Total added sugar		.32	.38		**.29**	**.02**		.20	.70
Age	-1.4 (-3.4, .6)		.16	-.74 (-1.5, .06)		.07	-.52 (-2.6, 1.5)		.60
Years of residency	-4.8 (-29.0, 19.3)		.68				18.2 (-19.2, 55.5)		.32
BMI	.96 (-1.4, 3.3)		.41	-.15 (-1.0, .7)		.74	-.30 (-3.5, 2.9)		.85
Marital status	**-28.5 (-56.4, .6)**		**.05**	**-15.7 (-29.0, -2.4)**		**.02**	8.2 (-24.3, 40.8)		.60
Number of dependent children	7.2 (-4.2, 18.7)		.20	4.1 (-3.3, 8.5)		.07	-1.6 (-12.1, 8.9)		.75
Edu levels	23.7 (-16.7, 64.1)		.23	7.1 (-6.8, 21.0)		.31	-14.9 (-40.9, 11.1)		.25
Employ status	-23.1 (-81.4, 35.1)		.41	**-14.4 (-27.7, -1.0)**		**.04**	-17.5 (-41.9, 6.9)		.15

Multiple linear regression were performed.

Table 6: The association between demographic and percent of recommended dietary variables

	US			SA			KR		
	B (95% CI)	**R^2**	**p**	**B (95% CI)**	**R^2**	**p**	**B (95% CI)**	**R^2**	**p**
% recommended grain		.19	.76		.20	.16		.16	.81
Age	-.92 (-5.7, 3.9)		.69	**1.6 (.31, 2.9)**		**.02**	.90 (-2.1, 3.9)		.54
Years of residency	4.4 (-54.0, 52.9)		.87				14.9 (-40.3, 70.1)		.58
BMI	-4.7 (-10.4, 1.1)		.11	-1.1 (-2.5, .40)		.15	-1.8 (-6.6, 2.9)		.44
Marital status	11.6 (-55.9, 79.1)		.72	14.3 (-7.6, 36.3)		.19	-3.4 (-51.5, 44.6)		.88
Number of dependent children	6.5 (-21.1, 34.2)		.62	-6.5 (-13.8, 8.0)		.08	-8.8 (-24.3, 6.7)		.25
Education levels	29.5 (-68.3, 127)		.53	-4.5 (-27.4, 18.4)		.69	-16.9 (-55.3, 21.5)		.37
Employment status	4.3 (-137, 145)		.95	10.2 (-11.9, 32.2)		.36	-6.4 (-42.5, 29.6)		.71
% recommended vegetable		.11	.94		.09	.70		.26	.49
Age	1.4 (-4.4, 7.2)		.63	.95 (-.7, 2.6)		.26	2.3 (-1.9, 6.5)		.26
Years of residency	15.6 (-55.5, 86.8)		.65				-63.3 (-139, 12.9)		.10
BMI	-2.3 (-9.3, 4.8)		.51	-1.4 (-3.3, .48)		.14	-2.7 (-9.2, 3.9)		.40
Marital status	20.8 (-61.4, 103)		.60	7.2 (-20.9, 35.2)		.61	-46.3 (-113, 20.1)		.16
Number of dependent children	-2.1 (-35.8, 31.5)		.90	-4.9 (-14.2, 4.5)		.30	7.9 (-13.5, 29.3)		.45
Education levels	7.2 (-112, 126)		.90	4.2 (-25.1, 33.5)		.78	-2.8 (-55.8, 50.3)		.92
Employment status	-66.2 (-238,105)		.43	3.1 (-25.0, 31.3)		.82	-6.9 (-56.7, 42.8)		.77
% recommended fruit		**.56**	**.03**		.14	.36		.18	.77
Age	3.8 (-3.6, 11.1)		.30	1.4 (-1.3, 4.0)		.30	.8/4 (-3.6, 5.3)		.70
Years of residency	3.1 (-86.4, 92.6)		.94				-54.7 (-136, 27.0)		.18
BMI	1.8 (-7.1, 10.6)		.68	-1.6 (-4.6, 1.3)		.27	-.11 (-7.1, 6.9)		.98
Marital status	7.3 (-96.0, 111)		.88	33.9 (-10.3, 78.0)		.13	-10.0 (-81.1, 61.1)		.77
Number of dependent children	19.5 (-22.8, 61.8)		.35	-8.0 (-22.7, 6.8)		.28	5.5 (-17.5, 28.4)		.62
Education levels	**-238 (-387, -88.3)**		**.004**	33.9 (-12.2, 80.0)		.15	36.5 (-20.2, 93.3)		.19
Employment status	51.5 (164, 267)		.62	-3.5 (-47.9, 40.8)		.87	20.2 (-33.1, 73.4)		.44

% recommended dairy		**.42**	**.16**		**.12**	**.51**		**.29**	**.41**
Age	**2.4 (.12, .47)**		**.04**	.90 (-.55, 2.4)		.22	1.6 (-1.5, 4.8)		.29
Years of residency	-1.7 (-29.6, 26.2)		.90				-30.9 (-88, 26.2)		.27
BMI	-1.9 (-4.7, .8)		.16	-.31 (-1.9, 1.3)		.70	-4.3 (-9.3, 0.6)		.08
Marital status	**41.6 (9.4, 73.8)**		**.01**	4.8 (-19.4, 29.0)		.69	-20.3 (-70.0, 20.4)		.40
Number of dependent children	-11.8 (-25.0, 1.4)		.08	-4.7 (-12.8, 3.3)		.24	-.03 (-16.1, 16.1)		1.0
Education levels	3.3 (-43.3, 49.9)		.88	10.6 (-14.7, 35.9)		.40	7.4 (-32.3, 47.1)		.70
Employment status	21.1 (-46.1, 88.4)		.52	11.0 (-13.3, 35.3)		.37	-23.8 (-61.1, 13.5)		.20
% recommended SAT		**.52**	**.05**		.17	.24		**.53**	**.03**
Age	.11 (-4.0, 4.2)		.96	2.5 (.4, 4.7)		.02	**5.0 (.9, 9.0)**		**.02**
Years of residency	5.9 (-44.6, 56.3)		.81				-32.5 (-106, 41.2)		.37
BMI	-4.6 (-9.6, .4)		.37	**-2.4 (-4.8, -.1)**		**.04**	**-10.1 (-16.5, -3.8)**		**.003**
Marital status	**63.6 (5.3, 122)**		**.03**	6.8 (-28.4, 41.9)		.70	-51.9 (-116, 12.3)		.11
Number of dependent children	-3.1 (-26.9, 20.8)		.79	-6.6 (-18.3, 5.1)		.26	-7.5 (-28.2, 13.2)		.46
Education levels	**-83.8 (-168, .57)**		**.05**	.57 (-36.1, 37.3)		.98	-24.2 (-75.4, 27.1)		.34
Employment status	35.8 (-85.8, 157)		.51	6.4 (-29.9, 40.8)		.76	**-54.0 (-102, -5.9)**		**.03**
% recommended added sugar		.45	.12		**.42**	**.0001**		.21	.64
Age	-2.3 (-5.3, .8)		.13	**-1.8 (-3.1, -.5)**		**.009**	-1.8 (-6.3, 2.7)		.41
Years of residency	-11.9 (-49.3, 25.4)		.51				54.3 (-27.6, 136)		.18
BMI	1.5 (-2.1, 5.2)		.39	-.4 (-1.8, 1.1)		.60	-.4 (-7.5, 6.6)		.90
Marital status	**-59.4 (-103, -16.4)**		**.01**	**-29.4 (-51.1, -7.7)**		**.009**	24.8 (-46.6, 96.1)		.48
Number of dependent children	7.8 (-9.8, 25.5)		.36	**9.8 (2.5, 17.0)**		**.009**	-2.3 (-25.3, 20.8)		.84
Education levels	46.2 (-16.2, 109)		.14	21.7 (-1.0, 44.4)		.06	-27.2 (-84.2, 29.9)		.33
Employment status	-43.4 (133, 46.6)		.32	**-32.1 (-53.9, -10.2)**		**.005**	-34.3 (-87.8, 19.2)		.20

% recommended sodium	**.21**	**.73**	**.12**	**.50**	**.37**	**.21**
Age	.59 (-5.3, 6.5)	.84	1.2 (-.7, 3.2)	.21	2.7 (-.6, 5.9)	.11
Years of residency	-10.7 (-82.9, 61.4)	.76			-25.0 (-84.9, 35.0)	.39
BMI	-5.1 (-12.2, 2.1)	.15	.04 (-2.1, 2.2)	.97	-1.0 (-6.2, 4.1)	.69
Marital status	27.8 (-55.5, 111)	.49	13.1 (-19.3, 45.4)	.42	-29.9 (-82.1, 22.3)	.25
Number of dependent children	-.6 (-34.7, 33.5)	.97	-9.1 (-19.8, 1.7)	.10	-7.9 (-24.7, 9.0)	.34
Education levels	48.0 (-72.6, 169)	.41	-8.0 (-41.7, 25.7)	.64	-16.8 (-58.5, 24.9)	.41
Employment status	-63.0 (-237, 111)	.46	17.5 (-14.9, 50.0)	.28	-22.3 (-61.5, 16.8)	.25

The predictors entered were age, year of residency, BMI, marital status, number of dependent children, education and employment status.
Multiple linear regression were performed.

Table 7: Comparisons of macronutrient intakes and percentage of recommended intakes according to marital status (Mean±SEM) (n)

	SA		US		KR	
	Single (26)	**Married (22)**	**Single (7)**	**Married (18)**	**Single (9)**	**Married (18)**
Energy (kcal)	1999±95	1991±111	1735±98	**2328±184****	1865±151	1589±120
Protein (g)	74.8±4.4	77.8±4.8	60.1±6.5	78.1±5.9[#]	83.2±8.2	**59.0±5.1****
Carbohydrate (g)	251±13	241±16	244±15.1	**316±30***	206±22.5	188±14.0
Total fiber (g)	16.8±1.3	18.9±1.3	17.3±1.5	26.9±3.5	15.1±2.5	16.9±1.6
Fat (g)	79.5±4.6	82.7±5.5	61.3±5.7	**88.7±6.9***	80.0±12.5	69.4±6.4
SAT (g)	27.8±2.1	28.2±2.4	20.2±3.3	27.8±2.6	26.3±6.0	21.9±2.0
% recommended grain	90.2±6.7	100.0±6.6	101±12.5	95.1±13.9	85.8±13.5	69.2±6.5
% recommended vegetable	53.6±6.7	55.8±9.7	59.3±27.4	77.1±13.5	77.4±21.6	76.4±9.3
% recommended fruit	26.7±6.2	50.8±18.7	40.7±13.5	**123±30.0***	29.2±17.7	34.4±11.3
% recommended dairy	48.8±6.9	49.0±7.3	32.0±5.7	50.9±7.6	42.3±18.6	38.1±5.7
% recommended protein	98.0±10.7	98.4±9.6	80.0±18.8	86.3±12.3	122±16.5	**70.9±10.1****
% recommended SAF	129±9.3	135±12.2	91.0±15.4	132±14.4	119±28.7	102±9.5
% recommended added sugar	72.7±7.8	51.2±7.1	82.2±13.7	**37.7±8.4****	35.3±19.4	44.3±11.1
% recommended sodium	134±7.6	136±11.6	146±34.2	158±13.1	148±14.3	127±9.2

* p<0.05; **p<0.01; [#] 0.10>p>0.05
Student's t-tests were perform.
Bold numbers indicated that there was a significant difference among the groups.

Table 8: Comparisons of macronutrient intakes and percentage of recommended intakes according to employment status[1] (Mean±SEM) (n)

	SA		KR	
	Unemployed (21)	Employed (27)	Unemployed (20)	Employed (7)
Energy (kcal)	1989±81	2000±113	1805±103	**1327±172***
Protein (g)	72.9±4.0	78.9±4.9	74.2±5.3	**46.8±6.3****
Carbohydrate (g)	246±10	246±16	199±13.6	178±25.0
Total fiber (g)	15.1±1.0	**19.6±1.4***	18.1±1.7	**11.1±1.7***
Fat (g)	80.8±4.9	81.1±5.0	81.6±6.7	**48.0±6.0****
SAT (g)	27.9±2.2	28.0±2.2	26.6±2.8	**14.1±1.2***
% recommended grain	90.2±4.9	98.2±7.5	74.7±12.6	75.0±12.6
% recommended vegetable	51.5±7.6	57.0±8.3	83.8±11.2	56.7±13.9
% recommended fruit	29.0±6.8	44.5±15.5	31.4±9.3	36.6±26.1
% recommended dairy	39.1±5.0	**56.4±7.7**[#]	46.5±8.9	**19.4±4.8**[#]
% recommended protein	97.9±11.2	98.5±9.6	99.0±11.3	**56.0±13.8***
% recommended SAT	132±9.5	132±11.1	123±13.6	**65.4±5.4****
% recommended added sugar	78.0±8.4	**51.4±6.6***	45.6±12.6	29.1±9.9
% recommended sodium	124±8.1	143±9.8	142±7.2	**110±20.7**[#]

1: Only one participant in the US was employed, hence no statistical analysis was performed

* $p<0.05$; ** $p<0.01$; [#] $0.10>p>0.05$

Student's t-tests were perform.

Bold numbers indicated that there was a significant difference among the groups.

Table 9: Comparisons of macronutrient intakes and percentage of recommended intakes according to education levels[1] (Mean±SEM) (n)

	SA		KR	
	High school or less (17)	More than high school (31)	High school or less (6)	More than high school (21)
Energy (kcal)	2058±108	1960±95	1834±241	1637±104
Protein (g)	75.4±4.4	76.6±4.4	64.3±9.2	67.9±5.7
Carbohydrate (g)	253±14.2	243±13.6	221±28.9	186±12.7
Total fiber (g)	17.9±1.6	17.5±1.2	18.1±3.4	15.8±1.5
Fat (g)	84.3±5.6	79.2±4.5	80.1±13.0	70.9±6.7
SAT (g)	28.5±2.5	27.7±2.0	23.9±3.8	23.2±2.9
% recommended grain	97.4±8.2	93.2±5.9	77.3±12.5	74.0±7.4
% recommended vegetable	52.5±7.9	55.8±7.7	82.2±22.6	75.2±10.3
% recommended fruit	18.7±5.5	**48.2±13.7***	11.2±5.8	38.9±11.7
% recommended dairy	39.1±6.4	54.2±6.7	30.8±6.0	42.0±8.9
% recommended protein	99.8±10.1	97.3±9.8	85.0±14.5	88.7±11.9
% recommended SAF	137.5±11.9	129±9.6	109±17.1	107±13.8
% recommended added sugar	58.8±9.1	65.4±7.0	60.9±28.2	35.7±9.6
% recommended sodium	133±11.1	136±8.4	140±18.1	132±8.9

1: Only two participants in the US had high school or less education levels, hence no statistical analysis was performed.
Student's t-tests were perform.
Bold numbers indicated that there was a significant difference among the groups.

Table 10: Association Between years of residency abroad and BMI and food intake patterns (mean±SEM) in participants residing in the US and in the KR (n)

Dietary Intake	Years in the US			Years in the KR			p		
	0 years (48)	< 5 years (18)	> 5 years (7)	0 years (48)	< 5 years (24)	> 5 years (3)	Country	Years of residency	interaction
BMI (kg/m²)	25.8±1.0	26.9±1.4	26.2±1.5	25.8±1.0	26.7±0.8	23.5±1.8	0.57	0.59	0.84
Energy (kcal)	1995±72	2197±186	2072±223	1995±72	1724±103	1335±164	**0.01**	0.33	**0.02**
Protein (g)	76.2±3.2	70.9±6.2	78.7±3.9	76.2±3.2	68.4±5.3	56.2±8.8	0.18	0.23	0.41
Carbohydrates (g)	246±10	305±28	273±38	249±10	198±13	158±15	**<0.001**	0.47	**<0.001**
Total fiber (g)	17.6±0.9	22.9±2.5	27.4±7.3	17.6±0.9	17.2±1.4	9.3±1.6	**<0.001**	0.27	**0.003**
Total sol. Fiber (g)	0.6±0.1	1.4±0.1	1.0±0.4	0.6±0.1	0.2±0.1	0.3±0.2	**0.004**	0.59	**<0.001**
Total sugar (g)	86.6±5.8	123±16	120±28	86.6±5.8	70.8±7.1	57.9±1.4	**0.001**	0.46	**0.003**
Added sugar (g)	31.6±3.0	27.3±6.2	22.4±6.9	31.6±3.0	17.5±4.9	21.9±4.9	0.55	0.06	0.49
Total fat (g)	81.0±3.5	81.9±7.5	78.7±8.0	81.0±3.5	75.4±6.4	52.9±8.2	0.12	0.27	0.36
SAT (g)	28.0±1.6	26.0±2.8	24.9±3.5	28.0±1.6	24.3±2.6	16.3±3.8	0.24	0.10	0.54
MOFA (g)	18.0±1.2	17.4±2.6	15.5±4.0	18.0±1.2	15.7±2.4	13.7±2.1	0.63	0.47	0.87
PUFA (g)	11.2±0.9	11.7±1.8	9.8±2.7	11.2±0.9	9.8±1.4	9.1±0.9	0.61	0.70	0.34
tFA (g)	0.32±0.1	0.14±0.1	0.50±0.3	0.32±0.1	0.51±0.13	0.10±0.1	0.95	0.99	0.06
Cholesterol (mg)	247±16	237±24	388±53	247±16	287±35	389±56	0.59	**0.008**	0.54
% recommend - grain	94.7±4.7	95.4±14.0	101±13	94.7±4.7	74.3±7.1	78.8±6.3	0.14	0.36	0.26
% recommend - vegetable	54.6±5.7	70.7±11.2	75.9±35.4	54.6±5.7	81.6±9.9	37.7±6.8	0.42	**0.04**	0.35
% recommend – fruit	37.7±9.2	110±28	74.4±34.2	37.7±9.2	35.8±10.4	8.3±8.5	**0.01**	**0.03**	**0.02**
% recommend – dairy	48.9±5.0	45.1±7.4	47.0±10.4	48.9±5.0	42.0±7.6	19.3±17.2	0.25	0.36	0.53
% recommend – protein	98.2±7.2	76.9±11.9	104±19	98.2±7.2	87.6±10.7	89.7±20.6	0.92	0.23	0.75
% recommend – SAT	132±7.5	122±15	116±18	132±7.5	111±12	81.0±21.1	0.28	0.11	0.61
% recommend – added sugar	63.1±5.5	51.9±10.0	45.6±15.3	63.1±5.5	38.4±10.7	65.1±3.9	0.85	0.07	0.49
% recommend – sodium	135±7	159±18	143±18	135±7	139±8	98±8	0.09	0.17	0.28

Abbreviations: SAT: saturated fats; MOFA: monounsaturated fats; PUFA: polyunsaturated fats; tFA: *trans* fats; % recommend: percent of recommended intake based on MyPlate.
Note: Bold numbers indicated that there was a significant difference among the groups.
General linear model analyses (ANOVA) were perform.

Table 11: Comparison between Saudi intake in SA and SA in the US, SA in the US and US general

Dietary Intake	SA in SA	SA in US	US general	SA in SA vs SA in US	SA in US vs US general
Energy (kacl)	1995±72	2162±144	1842±22	P=0.25	**P=0.04**
Protein (g)	76±3	73±5	70±1.0	P=0.58	P=0.53
Carbohydrate (g)	246±10	296±23	216±3.5	**P=0.02**	**P=0.002**
Total fiber (g)	19±1	24±3	16±0.4	**P=0.005**	**P=0.005**
Total sugar (g)	87±6	123±14	96±2.5	**P=0.006**	**P=0.06**
Total fat (g)	81±3.5	81±7.5	75±1.2	P=1.0	P=0.30
Saturate fat	28±1.6	25.7±2.2	24±0.5	P=0.40	P=0.44
MUFA	18±1.2	17±2.2	26±0.6	P=0.62	**P<0.001**
PUFA	11±0.9	12±1.5	18±0.4	P=0.97	**P<0.001**
Cholesterol (mg)	247±16	279±26	259±6	P=0.28	P=0.45

Student's t-tests were performed for SA in SA vs SA in US. One-sample t-tests were performed for SA in US vs US general.
Bold numbers indicated that there was a significant difference between the groups.

Table 12: Comparison between Saudi intake in SA and SA in the KR, SA in the KR and KR general

Dietary Intake	SA in SA	SA in KR	KR general	SA in SA vs SA in KR	SA in KR vs KR general
Energy (kacl)	1995±72	1681±96	1,754 ± 10.2	**P=0.011**	P=0.45
Protein (g)	76±3	67±5	61.4	P=0.12	P=0.25
Carbohydrate (g)	246±10	194±12	293.8	**P=0.002**	**P<0.001**
Total fat (g)	81±3.5	73±6	37	P=0.21	**P<0.001**

One-sample t-tests were perform between SA in KR and KR general
Student's t-tests were performed for SA in SA vs SA in KR. One-sample t-tests were performed for SA in KR vs KR general.
Bold numbers indicated that there was a significant difference between the groups.

Table 13: Comparisons of mean BMI according to chronic disease status of participants from three countries combined (Mean±SEM) (n)

Chronic Diseases	Yes (n)	No (n)
Hypertension	**35.2±2.2 (12)**	**25.0±0.48** (88)**
Heart Disease	**37.5±3.1 (2)**	**26.0±0.58*(98)**
High Cholesterol	**31.1±1.2 (15)**	**25.3±0.62** (85)**
Sleep Apnea	29.0±9.3 (4)	26.1±.51 (96)
Asthma	**41.4±7.5 (3)**	**25.7±.51** (97)**
Allergies	**27.8±1.7 (25)**	**25.6±0.54** (75)**
Diabetes	30.3±2.6 (6)	25.9±0.60 (94)
Arthritis	**35.1±3.1 (8)**	**25.4±0.52 (92)**
Muscles Tendons Problem	**32.8±6.3 (5)**	**25.8±0.52** (95)**
Skin Problem	26.2±1.9 (11)	26.2±0.63 (89)
Renal Problem	32.5±2.7(2)	26.1±.60(98)
Ear Nose Throat Problems	**33.9±3.9 (8)**	**25.5±0.50** (92)**
Dental Problem	**30.2±2.5 (14)**	**25.5±0.53* (86)**

Note: * p<0.05; ** p<0.01; a:p=0.08
Student's t-tests were perform.
Bold numbers indicated that there was a significant difference between the groups.

Table 14: Comparisons between BMI according to chronic disease status in participants residing in each country (Mean±SEM)

Chronic Diseases	SA		US		KR	
	Yes (n)	No (n)	Yes (n)	No (n)	Yes (n)	No (n)
Hypertension	**35.6±2.9 (9)**	**23.6±0.68# (39)**	(1)	(24)	33.4±2.3 (2)	25.8±0.68 (25)
Heart Disease	37.5±3.1 (2)	25.3±0.99 (46)	(0)	(25)	(0)	(27)
High Cholesterol	33.0±1.9 (6)	24.8±1.0 (42)	27.1±1.5 (5)	26.6±1.3 (20)	33.4±1.3 (4)	25.1±0.53 (23)
Sleep Apnea	**29.0±9.3 (4)**	**25.5±0.81** (44)**	(0)	(25)	(0)	(27)
Asthma	**44.2±12.1 (2)**	**25.0±0.81** (46)**	(0)	(25)	(1)	(26)
Allergies	**27.2±2.0 (20)**	**24.8±0.96* (28)**	30.4±3.2 (4)	26.0±1.1 (21)	(1)	(26)
Diabetes	29.1±4.2 (3)	25.6±1.06 (45)	(1)	(24)	29.6±5.9 (2)	26.1±0.71(25)
Arthritis	**36.4±4.1 (6)**	**24.3±0.79# (42)**	31.0±0.50 (2)	26.3±1.2 (23)	(0)	(27)
Muscles Tendons Problems	**32.8±6.3 (5)**	**25.0±0.84** (43)**	(0)	(25)	(0)	(27)
Skin Problem	26.5±2.6 (8)	25.7±1.1 (40)	25.0±2.5 (2)	26.9±1.2 (23)	(1)	(26)
Renal Problem	32.5±2.7 (2)	25.5±1.0 (46)	(0)	(25)	(0)	(27)
Ear Nose Throat Problems	**33.9±4.5** (7)	**24.4±0.77**** (41)	(1)	(24)	(0)	(27)
Dental Problem	**31.9±3.7 (9)**	**24.4±0.81* (39)**	31.4±3.9 (2)	26.3±1.1 (23)	24.5±0.85 (3)	26.6±0.83(24)

Note: * p<0.05; ** p<0.01, p<0.001; # 0.10>p>0.05
No statistics are computed for less than 2 participants.
Student's t-tests were perform.
Bold numbers indicated that there was a significant difference between the groups.

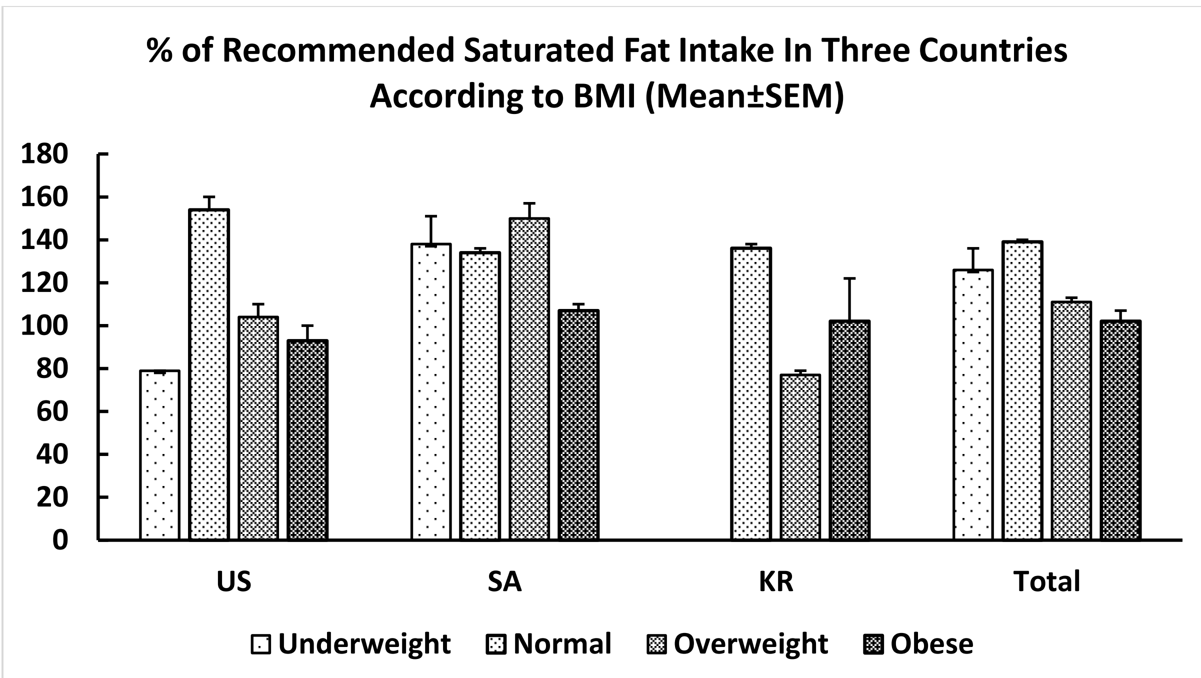

Figure 1: Associations between country, BMI and their interaction and percentage of recommended saturated fat intake. No differences were observed among the BMI categories within each country, however, with all participants combined, normal weight participants consumed significantly higher percentage of recommended SAT fat (p=0.02).

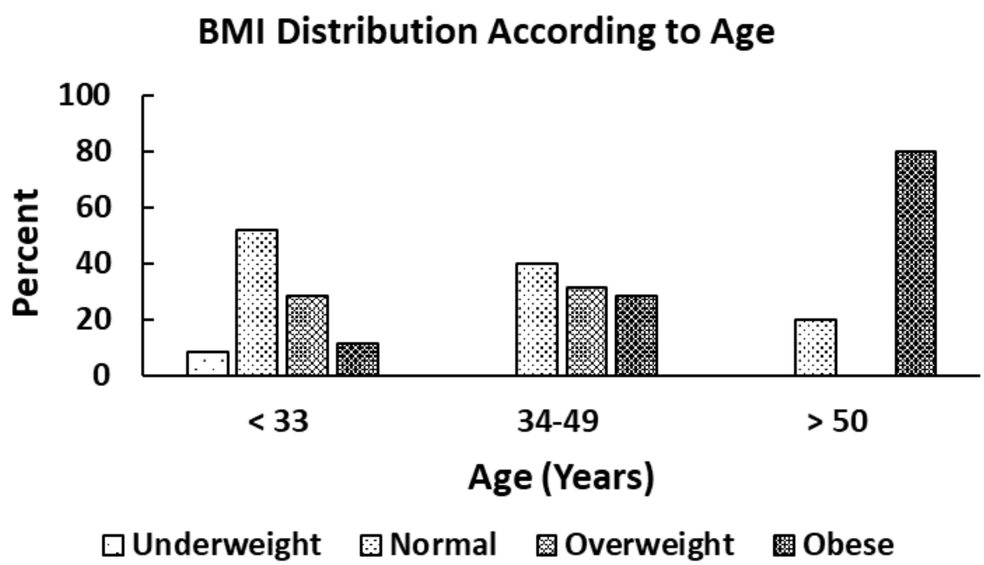

Figure 2: BMI distribution by age category. BMI distribution percent was significantly different among the age categories (p=0.006)

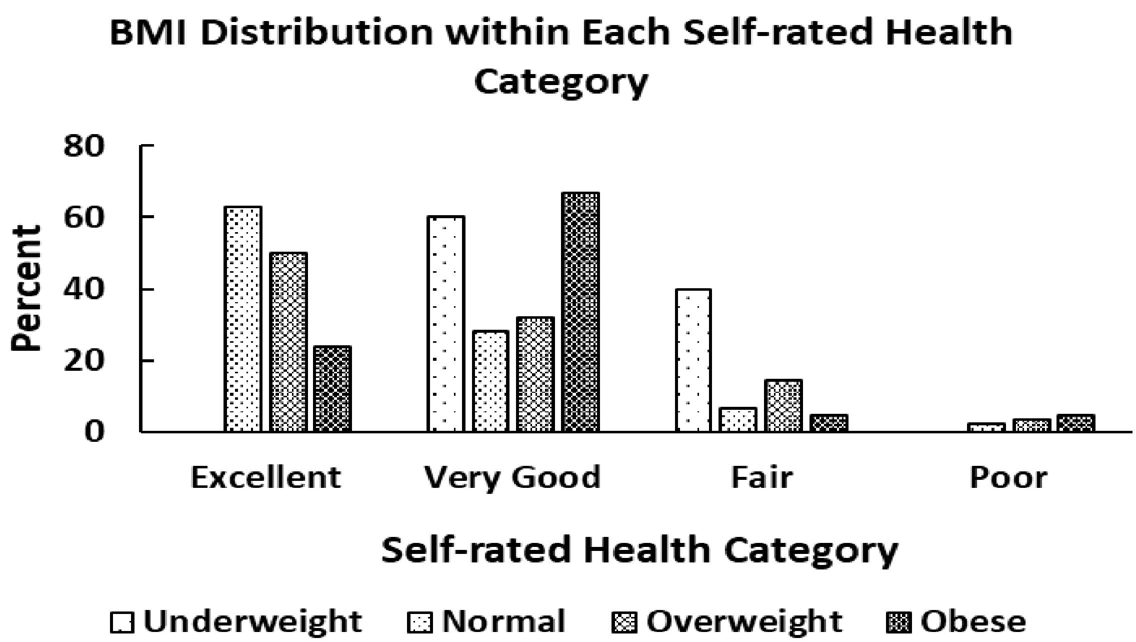

Figure 3: BMI distribution by self-reported health rate category. The distribution of BMI was significantly different among the self-rated health categories (p=0.02)

APPENDIX A

24-HOUR DIETARY RECALL

ID # ______________________
Date ______________________

DAY OF THE WEEK M T W R F S U	SERVING SIZE	PREPARATION METHOD	SPECIFIC TYPE (IF KNOWN)	RESTAURANT/BRAND NAME
List approximate times of meals	cups, Tbs, tsp, oz, fl oz, "item"	Baked, fried, boiled, steamed	Wheat, rye, fat-free, w/ or w/o skin	General Mills, Kelloggs, McDonalds, Pizza Hut, Nabisco, etc.
BREAKFAST				
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				
11				
12				
MORNING SNACK				
1				
2				
3				
4				
5				
6				
LUNCH				
1				
2				
3				

4				
5				
6				
7				
8				
9				
10				
11				
12				
13				
14				
AFTERNOON SNACK				
1				
2				
3				
4				
5				
6				
DINNER				
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				
11				
12				
13				
14				
EVENING SNACK				
1				
2				
3				
4				

5				
6				
7				

APPENDIX B

تقرير غذائي ل 24 س الماضية

الرمز #____________
التاريخ______________

يوم من أيام الاسبوع س, ح, ث, ل, ع, خ, ج	حجم الحصه	طريقة التحضير	نوع محدد اذا عرف	المطعم/ الاسم التجاري
أسرد الأوقات التقريبيه للطعام المتناول	كوب، ملعقة طعام، ملعقة شاي، اوقيه\جم\مليليتر	مخبوز، مقلي، مسلوق، على البخار	قمح، راي، خالي من الدسم، مع او بدون الجلد	المطاحن العامه، كلوقز، ماكدونالدز، بيتزاهت، نابيسكو، الخ
الأفطار				
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				
11				
12				
وجبة خفيفة في الصباح				
1				
2				
3				
4				
5				
6				
الغداء				
1				
2				
3				
4				
5				
6				

7				
8				
9				
10				
11				
12				
13				
14				
وجبة خفيفة بعد الظهر				
1				
2				
3				
4				
5				
6				
العشاء				
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				
11				
12				
13				
14				
وجبة خفيفة في المساء				
1				
2				
3				
4				
5				
6				
7				

APPENDIX C

Please provide your accurate answers. Thank you for your support and cooperation.

SECTION A: DEMOGRAPHICS

I am going to ask you some information about yourself.

A.1. How old are you?
______Years old

A.2. What is your gender?
1-Female 2-Male

A.3. What is your primary language?
1-Arabic 2-English 3-Other please specify ________

A.4. Birthplace:
1-Saudi Arabia 2-Iraq 3-Yemen 4-U.S. 5-Other, please specify________

A.5. How long have you been in the U.S. (if you U.S. participants only)
1-Less than 3 months 2-Less than 4 year 3-Less than 5 years
4-For 10-15 years 5-More than 15 years

A.6. What is the highest level of education you have completed?
1-No former education 2-Primary school graduate 3-Middle school graduate
4-High school graduate 5-Some college 6-College graduate
7-Graduate or professional degree

A.7. What is your occupation?_______________

A.8. Current employment status
1-Employed full-time working in my original profession
2-Employed part-time working in my original profession
3-Employed below my level of expertise
4-Self-employed
5-Unemployed (Please specified: I. Full time students; II. Retired; III. Homemaker; IV. Laid off; V. Other)

A.9. Marital status:
1-Single or never married 2-Married 3-Widowed 4-Divorced 5-Separated

A10. Do you currently live alone?
1-Yes (skip to question A.12) 2-No

A11. Not include yourself, how many other people live in the household? ______

A12. Are you a parent?
1-Yes (number of children _) 2-No (skip to question A.14)

A.13. How many children <18 years old in this house hold?_______

A14. What is your race? (Note: we know that your ethnicity is Arabic, but in which racial group do you consider yourself to be?)
1-White 2-Black 3-Asian 4-Two or more races 5-None of these

A.15. What is your religion?

1-Islam 2-Christian 3-Jewish 4-Other ______

SECTION B: HEALTH STATUS & PHYSICAL ACTIVITIES

The next few questions ask you about your health and your physical activity level.

B.1. Do you have health insurance?
1-Yes 2-No

B.2. How would you rate your general health today?
1-Excellent 2-Very good 3-Good 4-Fair 5-Poor

B.3. How much do weight? ________kg. or _________lbs.

B.4. How tall are you? __________cm or ______ft______inches

B.5. Do you smoke?
1-Yes 2-No

B.6. Do you drink alcohol?
1-Yes 2-No (skip to question B.8)

B.7. How often you usually drink alcohol?
1-(0 – 1 day/week) 2-(2 – 3 days/week) 3-(4 – 5 days/week) 4-Occasionally 5-Almost daily

B.8. How many times per week do you exercise extremely hard? (e.g., jump rope)
0 1 2 3 4 5 6 7 more than 7 (if 0 please skip to B.10)

B.9. How much time do you spend when you exercise hard?
1-_____Hours 2-_____Minutes 3-Don’t know

B.10. How many times per week do you exercise moderately? (e.g., doing daily chores)
0 1 2 3 4 5 6 7 more than 7 (if 0 please skip to B.12)

B.11. How much time do you spend when you do moderate exercise?
1-_____Hours 2-_____Minutes 3-Don't know

B.12. How many times per week do you walk for at least 30 minutes?
0 1 2 3 4 5 6 7 more than 7 (if 0 please skip to B.14)

B.13. When I walk, I usually spend
1-_____Hours 2-_____Minutes 3-Don't know

B.14. How much times do you usually spend on sitting (exclude the weekend)?
1-_____Hours 2-_____Minutes 3-Don't know

B.15. How do you usually get to work/school/mall?
1-Take a bus 2-Taxi 3-Get a ride from someone else
4-Ride a bike 5-Drive a car 6-Walk

B.16. Please answer yes or no if you have been diagnosed with any of the following medical conditions.

1-High blood pressure	1-Yes	2-No	
2-Heart disease	1-Yes	2-No	
3-High cholesterol	1-Yes	2-No	
4-Obstructive sleep apnea	1-Yes	2-No	
5-Asthma	1-Yes	2-No	
6-Allergies (not asthma)	1-Yes	2-No	
7-Diabetes	1-Yes	2-No	
8-Arthritis or rheumatism	1-Yes	2-No	
9-Any disease of the muscles or tendons	1-Yes	2-No	
10-Any skin problem	1-Yes	2-No	
11-Ear, nose, and throat disorders	1-Yes	2-No	
12-Cancer (if any type), if yes,	1-Yes	2-No	specify:______________
13-Renal problem	1-Yes	2-No	
14-Traumatic brain injury	1-Yes	2-No	
15-Dental problems	1-Yes	2-No	
16-Other	1-Yes	2-No	specify:______________

B.17. Please answer yes or no if you take any of the following nutritional supplements, if yes please name the brand and doses.

			Brand name	Doses
1- Multivitamins	1-Yes	2-No	____________	______
2-Vitamin D	1-Yes	2-No	____________	______
3-Folic acid	1-Yes	2-No	____________	______
4-Omega 3	1-Yes	2-No	____________	______
5- Fish oil	1-Yes	2-No	____________	______
6-Iron	1-Yes	2-No	____________	______
7-Calcium	1-Yes	2-No	____________	______
8-Biotin	1-Yes	2-No	____________	______
9-Supplements to lose weight	1-Yes	2-No	____________	______
10-Supplement to gain weight/muscles	1-Yes	2-No	____________	______
11-Supplements to increase energy	1-Yes	2-No	____________	______
12-Other, please specify:___________	1-Yes	2-No	____________	______

B.18. Please answer yes or no if you take any of the following medicines, if yes please name the brand and doses.

			Brand name	Doses
1-To lower blood sugar	1-Yes	2-No	____________	______
2-To lower cholesterol level	1-Yes	2-No	____________	______
3-To lower blood pressure	1-Yes	2-No	____________	______
4-To treat kidney disorder	1-Yes	2-No	____________	______
5-For heart vascular disease	1-Yes	2-No	____________	______
6-For stomach pain	1-Yes	2-No	____________	______
7-To treat depression	1-Yes	2-No	____________	______
8-To reduce anxiety	1-Yes	2-No	____________	______
9-For headache	1-Yes	2-No	____________	______
10-For asthma	1-Yes	2-No	____________	______
11-For allergy	1-Yes	2-No	____________	______
12-Other, please specify:___________	1-Yes	2-No	____________	______

SECTION C: FOOD PREPAREING AND DIETARY BEHAVIOR

I am going to ask you some questions about how you usually get your food, and your daily routine regarding to your daily food intake.

C.1. How many meals do you usually eat per day?
1-(1-2)   2-(2-3)   3-More than 3 meals   4-Don't know

C.2. How many times per week do you eat potato chips, candies, doughnut, etc.
1-(1-2) 2-(2-3) 3-More than 3 times 4-Don't know

C.3. How much do you spend on grocery per week? (USD)
(if the person live in Saudi Arabia please Skip to question C4)
1-Less than $10 5-$56 - $75
2-$10 - $15 6-$76 - $95
3-$16 - $35 7-$96 and above
4-$36 - $55

C4. How much do you spend on grocery per week? (SAR)
1-Less than 10 5-56-75
2-10-15 6-76-95
3-16-35 7-96 and above
4-36-55

C.5. Please list the food that you used to eat at your home country before you immigrate to the U.S. and you could not eat them after immigration.
1-…………… 6-……………
2-…………… 7-……………
3……………. 8…………….
4……………. 9…………….
5……………. 10…………...

C.6. How many times per a week did you use to eat these food (in the QC.5)?
1-(0-1) 2-(1-2) 3-(2-3) 4-More than 3 times

C.7. Is there any difference between your food that you eat and the food of other people who live in this household?
1-Yes, please specify_______ 2-No 3-I do not know

C.8. Is there another person than you prepare food for this household?
1-Yes, please specify_______ 2-No

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ABSTRACT

THE CHANGES IN DIETARY PATTERNS OF SAUDI WOMEN RESIDING IN SAUDI ARABIA, SOUTH KOREA, AND THE UNITED STATES: THE EFFECTS OF LENGTH OF RESIDENCY ON DIETARY ACCULTURATION

by

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Given the large and growing numbers of Saudi individuals living abroad, examining how their dietary patterns have changed and influenced by acculturation with host countries, as well as the health consequences of these changes is a research area that needs to be investigated. The primary objectives of the present study were to compare the food intake/nutrient intake patterns of Saudi women residing in Saudi Arabia (SA), South Korea (KR) and the United States (US), and how the length of residency in host countries affected food and nutrient intake patterns. This study hypothesized that dietary patterns were different among the three groups of women residing in these three countries; the longer they left SA, the more likely their intake patterns were different from those newly arrived in the host countries and those who remained in SA; and body mass index (BMI) levels were different among the three countries, and that the health-related parameters and percentage of recommended intakes were different among the BMI categories. This study was a secondary analysis of a cross-sectional 24-hour dietary recall data which were collected from 100 participants (48 residing in SA, 25 in the US,

and 27 in the KR) who lived abroad for less than or equal to five years or more than five years. The findings of the present study showed that dietary intakes were different among SA women in the three countries. The intake patterns were different between participants who were employed, more educated, or married as compared to those unemployed, less educated, or single. In addition, as the length of residency abroad increased, participants in both the US and KR showed different dietary intakes from those newly arrived in the US or KR and those who remained in SA. Acculturation was observed only in Saudi in the KR in terms of energy intake and protein intake in employed SA in KR. There was no significant difference in BMI among the participants of the three countries. Within each country, none of the percentage of recommended intakes were significantly different among the BMI categories. When combining the three countries together, percentage of recommended intake of SAT fat was significantly higher in participants with normal weight. No other nutrients showed any difference among the different BMI categories. Mean BMIs of participants with chronic diseases were significantly higher than those without chronic diseases. Only age and self-reported health status were significantly different according to BMI categories. Future research should recruit more participants to enlarger sample sizes, include male gender, use longitudinal research design, and administer acculturation questionnaires along with dietary recalls. In particular, we recommend including Saudi men and following these men and women for more than five years in the host countries in order to examine dietary acculturation and its effects on the development of chronic diseases in these expatriates.

AUTOBIOGRAPHICAL STATEMENT

Nouf Alharbi is a PhD candidate in Nutrition and Food Science at Wayne State University, Detroit, Michigan. She completed her undergraduate education at King Saud University, Riyadh, Saudi Arabia, where she earned a Bachelor Degree in Food Sciences and Human Nutrition with honors in 2009 as well as a Postgraduate Diploma in General Education in 2010. Afterwards, she worked for two years as a Nutrition educator at a local healthcare center in Riyadh, Saudi Arabia. In 2012, she joined the teaching staff at the Northern Border University in Saudi Arabia and worked as a teaching assistant for about one year. In 2016, Nouf earned a Master of Arts degree in Nutrition and Food Science from Wayne State University and, then, was promoted to a lecturer position at Northern Border University, Saudi Arabia.

After earning her PhD in Nutrition and Food Science, Nouf plans to continue teaching at the Northern Border University and build upon her four years’ experience in human research to pursue further research projects.