Journal of Aging Research & Clinical Practice©
Volume 4, Number 1, 2015

J Aging Res Clin Practice 2015;4(1):2-11
Published online January 27, 2015, http://dx.doi.org/10.14283/jarcp.2015.46

DIETARY PATTERNS, NUTRIENT INTAKES, AND NUTRITIONAL AND PHYSICAL ACTIVITY STATUS OF SAUDI OLDER ADULTS: A NARRATIVE REVIEW

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Abstract: *Objective:* to review the dietary patterns, nutrient intakes, and nutritional and physical activity status of older adults living in Saudi Arabia, to examine geographical differences in such patterns and to identify research gaps in respect of nutrition and physical activity for this population group. *Design:* Databases and websites (including Pubmed, Scopus, Proquest, Google Scholar and Arab Center for Nutrition) were searched in English and Arabic languages using the following key words: nutritional status, dietary pattern, food pattern, dietary habits, micronutrient intake and status, macronutrients intake, obesity, malnutrition, iron deficiency anemia, vitamin D, physical activity, exercise, Saudi older adults and Saudi elderly. All relevant and available data for both free-living and institutionalized Saudi older adults (> 50 years old or with mean age > 50 years) published in the last 20 years were included in this review. *Results:* We found that free-living females consumed fewer meals, and less fruits and vegetables, but their reported energy intake was higher than for males. Low intake of vitamins C and D were common in both genders and in those who lived in western and northern regions while low intake of folate and fiber were common in institutionalized people. Omega-3 fatty acids and fish were more highly consumed by older adults living in the coastal region compared with residents in the internal region. Obesity, overweight, vitamin D deficiency and insufficiency and physical inactivity were prevalent in free living older adults throughout the country while underweight and iron deficiency anemia were prevalent in institutionalized persons. *Conclusion:* Information on dietary patterns, nutrient intakes, and nutritional and physical activity status of older adults living in Saudi Arabia is fragmentary and interpretation of the findings is hampered by the lack of population-representative sampling frames and the use of heterogeneous data collection tools. More systematic studies are essential to facilitate objective assessment of these important lifestyle-related factors and to inform public health policies.

Key words: Dietary patterns, nutrient intakes, nutritional status, physical activity status, Saudi older adults.

Introduction

Ageing is a degenerative process that is characterized by reduced physiological function and increased risk of disease and death (1). Chronological age remains the most popular method to define aged or elderly but this approach is contested (2, 3). The World Health Organization uses 65 years as threshold to refer to older persons (elderly) whereas 80 years and over is a cutoff when referring to the oldest-old. Nevertheless, definitive categorization of older people is difficult because "old" is an individual-, culture-, country- and gender-specific term. For instance, many people in developing countries are functionally "old" in their forties and fifties (2). In Saudi Arabia, 60 years and above refers to older adults as it is considered as retirement age (4).

Around the world, the number of people aged ≥60 years is increasing (5, 6). In 2011, there were 784 million older people in thos category (11% of the total population). This number is projected to increase by 2.6 fold to reach 2 billion in 2050 (i.e. 22% of the population), and to reach 30% of the global population by 2100 with most of this increase occurring in the developing countries (5, 7). In Saudi Arabia, there were 417,252 older people (>60 years) in 1974 and this increased gradually to 907,529 (5.2 % of the Saudi population) in 2007 (8-11). This growing proportion of older people is due to decreasing fertility rate and increasing life expectancy (5, 12). Total fertility rate of Saudi women decreased from 3.6 in 2004 to 3.24 in 2009 and to 2.26 in 2012 (13, 14). In addition, life expectancy of Saudi people rose from 69 years in 1990 to 75 years in 2011 (15).

Whilst life expectancy is increasing, these extra years are not always spent in good health because the

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Received November 18, 2014
Accepted for publication December 15, 2014

risk of most common chronic diseases increases with age (16). Chronic conditions notably cardiovascular diseases, cancers, and diabetes together with other non-communicable diseases account for 78% of all deaths in the Saudi population (17). Diet and physical activity are major modulators of health throughout the life-course and contribute to health in later life (18). The rapid economic and social changes in Saudi Arabia in recent years have been accompanied by changes in food availability and in patterns of physical activity in work and leisure. Such changes are likely to contribute to changes in the health of older people but, to our knowledge, this topic has not been reviewed extensively. Thus, our objectives were to review the dietary patterns, nutrient intakes, and nutritional and physical activity status of older adults living in Saudi Arabia, to examine geographical differences in such patterns and to identify research gaps in respect of nutrition and physical activity for this population group. Since there is no national survey of diet, nutrition and lifestyle in Saudi Arabia, this review is based on data from all relevant surveys of individual population groups.

Methods

Several data bases including Pubmed, Scopus, Proquest and Google Scholar were searched. In addition, the website of King Fahad National Library was searched for Masters and PhD theses. Articles in the Arabic language in the Arab Journal of Food and Nutrition were searched through the website of the Arab Center for Nutrition. Key words used were: nutritional status, dietary pattern, food pattern, dietary habits, micronutrient intake and status, macronutrients intake, obesity, malnutrition, iron deficiency anemia, vitamin D, physical activity, exercise, Saudi older adults and Saudi elderly. All relevant and available data about both free-living and institutionalized Saudi older adults (> 50 years old or with mean age > 50 years) published in the last 20 years were included in the review. In case-control studies, results of controls are included if they were healthy and above 50 years old. Papers studying hospitalized patients or patients with kidney failure or liver diseases were excluded. Studies of other age groups and those of non-Saudis were also excluded.

Results

Dietary patterns

The dietary patterns of older Saudi adults of both genders living in different Saudi regions, and in different living situations, have been investigated in several studies. Alenezy (2003) found that 86% of 404 older males living in the northern region consumed 3 main meals per day (19). This percentage was lower in females (57.9%) living in Riyadh city (central region) (20). In 2005, Sadiq investigated the differences in number of meals consumed by 200 elderly females in Jeddah city (western region) before and after institutionalization and found that the number of females who consumed 3 main meals/day declined significantly after institutionalization. Moreover, the proportion of females who consumed snack meals decreased from 79.5 % to 55.5% (21).

Midhet et al (2010) studied the dietary habits of 2789 adult males and females in Al Qassim (central region). The proportion of respondents who reported higher rates of consumption of fish, vegetables, fresh fruits and grilled meats increased gradually with age among both genders. However, the proportion was higher in males (70%) compared with females (50%) (22). In the same region, Hosa (2004) investigated the dietary habits of a sample of older females living in Riyadh city. Results showed that 61.1 % of participants consumed 1 serving (1 slice) of bread daily while 40% consumed 1 cup of rice and pasta. This relatively low consumption of carbohydrate-rich foods was because most of the participants were diabetic and were prescribed low-carbohydrate diet. Although calcium is important for bone health and dairy products are rich sources of calcium, more than one third of the participants did not consume dairy products daily. Forty and 55% of participants did not consume vegetables and fruits (except dates), respectively, on a daily basis - Dates were highly consumed by 79.5% of participants. Thirty grams of red meats, poultry or fish were consumed by half the sample. More than two thirds did not consume fish whereas the rest consumed it 1 to 2 times per week (20). The proportion of fish consumers was higher (52%) in a sample of males and females living in Al Dammam, Al Qatif, Al Khafjy cities and other small villages in the eastern coastal region of Saudi Arabia (23). Changes in dietary patterns of older females before and after institutionalization were investigated by Sadiq (2005) who reported that the frequency of consumption of whole wheat bread, sweets, fresh vegetables, red meats, poultry, shrimp, egg and legumes decreased while consumption of white bread, pasta, biscuits, pastries, full fat fermented milk (laban) and powdered milk increased following institutionalization (21).

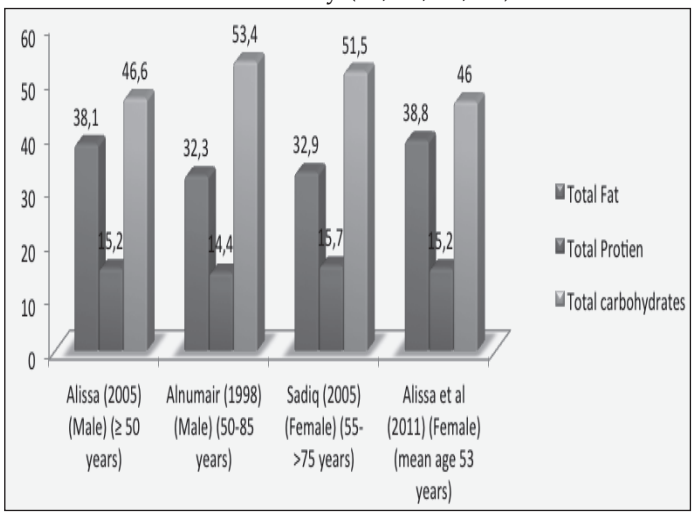
Many factors including ill health, disease, disability, poor dentition, living in institutions, socioeconomic status, taste and smell may influence food and nutrient intake and, therefore, the nutritional status of older people (16) but there is very little evidence about the impact of these factors on nutritional status in older adults in Saudi Arabia. In free living females, Hosa (2004) reported that more than half the respondents suffered from problems in saliva secretion and food swallowing and difficulties in chewing food due to poor dentition in institutionalized females were reported by Sadiq (2005) (20, 21).

Nutrient intake

Energy and energy-yielding macronutrients

The estimated average requirements (EAR) for energy declines during ageing (Table 1) (24). One reason for this fall is the decline in Basal Metabolic Rate (BMR) with age, with estimated declines of 2% and 2.9% per decade for normal weight females and males, respectively (25). Aging is correlated with changes in body composition, with increases in the proportion of body fat, while fat free mass decreases, leading to a reduction in BMR (16, 26). Studies investigating energy and energy-yielding macronutrient intakes in older adults in Saudi Arabia are limited but there is evidence that average daily energy intakes of Saudi older adults varies according to living situations, geographical region and gender. For example, daily intakes of free-living men (≥50 years) living in Jeddah city (the western region of Saudi Arabia) were 1834 kcal (below the RNI) (27), while intakes of women (50-85years) living in the same city were reported to be 2027 kcal (above the RNI) (28). In contrast, women (mean age 58) living in Riyadh city (central region) had mean daily energy intakes of 1502 Kcal (29). In institutionalized older adults, the mean daily energy intake of women (55 - 75+ years) was 1232 Kcal (well below the RDA) whereas the mean daily energy intake of men was 2795 Kcal (above RDA) (21, 30). Despite the wide differences in estimated total energy intake among different studies, the percentages energy provided as total fat, total protein and carbohydrates in several studies of both males and females were much less variable (summarized in Figure 1).

Figure 1
Percentages of dietary energy obtained from fat, protein and carbohydrates in 4 separate studies of the diets of Saudi elderly (21, 27, 28, 30)



Carbohydrate, dietary fiber and fat dietary recommendations for older people are the same as for other adults (31). However, protein recommendations are slightly changed in older adults compared with young adults. Male requirements are decreased while female requirements are increased (see Table 2) (31). Mean daily intake of fat, protein and carbohydrates in free-living men living in Jeddah city (the western region) were 78 g, 70 g and 213 g respectively (27). These values were slightly higher in women (living in the same city), where fat, protein and carbohydrates intake were 88g, 78 g and 232 g respectively (28). In contrast, women living in institutions reported considerably lower daily intakes of 47g, 47g and 160g of fat, protein and carbohydrates respectively (21).

Table 1
Estimated average requirements for energy (Kcal/day)

Age	Males	Females
19-24	2772	2175
25-34	2749	2175
35-44	2629	2103
45-54	2581	2103
55-64	2581	2079
65-74	2342	1912
75+	2294	1840

Source: Scientific Advisory Committee on Nutrition (2011) (24).

Table 2
Reference nutrient intakes for Protein (g/day)

Age	Males	Females
19-50	55.5	53.3
51+	45	46.5

Source: Department of Health (1991) (31).

Intake of different types of fatty acids by older females living in Jeddah city were reported by Alissa et al. (2011) who found that daily intake of saturated fatty acids (SFA), monounsaturated fatty acids (MUFA) and polyunsaturated fatty acids (PUFA) were 88 g, 28g, and 22g respectively (28). These values were slightly lower in males living in the same city, where SFA, MUFA and PUFA intake were 78g, 25g and 17g respectively (27). In 2005, Alnumair et al investigated the consumption of omega-3 fatty acids (n-3 FAs) in two samples of elderly men living in different geographical regions (coastal and internal regions). The intake of total n-3 FAs, alpha-linolenic acid, eicosapentaenoic acid and docosahexaenoic acid were twice as high among the coastal region residents than for the internal residents. The top five foods contributing to the n-3 FA intakes of coastal residents were English walnuts, salmon, canola oil, Malabar cavalla and king mackerel while English

walnuts, lamb, whole milk, baked beans and chicken were the top foods providing n-3 FA for the internal residents (32).

Table 3
Reference nutrient intake (RNI) for vitamins and minerals for adults over 50 years

nutrient	RNI	nutrient	RNI
Calcium (mg/d)	700	Copper (mg/d)	1.2
Phosphorus (mg/d)	550	Iodine (μg/d)	140
Magnesium (mg/d)	270 female 300 male	Zinc (mg/d)	7 female 9.5 male
Sodium (mg/d)	1600	Iron (mg/d)	8.7
Potassium (mg/d)	3500	Vitamin B12 (μg/d)	1.5
Chloride (mg/d)	2500	Folate (μg/d)	200
Selenium (μg/d)	600 female 75 male	Thiamin (mg/d)	0.8 female 0.9 male
Riboflavin (mg/d)	1.1 female 1.3 male	Niacin (mg/d)	12 female 16 male
Vitamin B6 (mg/d)	1.2 female 1.4 male	Vitamin D (μg/d)	(10μg/d after age of 65 years

Source: Department of Health (1991) (31).

Fiber intakes of males and females living in institutions in Riyadh and Jeddah were 15 g and 4 g, respectively and below the recommendations (RDA) (21, 30). In contrast, free-living males and females in Jeddah had fiber intakes of 18 g and 19 g/d respectively (27, 28) which are close to the recommendations.

Micronutrients

The micronutrient needs of older people are generally similar to those of young adults (see Table 3) but the recommendation for vitamin D is higher for older adults (31). Intakes of a range of micronutrients by older Saudi male and female from different regions and living conditions are summarized in Table 4. In brief, low intakes of vitamins A, D and C were common in males and females living in the western and northern regions (19, 21, 27, 28). Inadequate folate intake was reported in institutionalized males and females in Riyadh and Jeddah city respectively (21, 33). Low intakes of selenium, copper, zinc, iron and calcium were also found in older Saudis (21, 27, 28, 33). On the other hand, high intakes (above the RDA) of vitamin B12, selenium and zinc were found in free-living older males in the northern region (19).

Fluids

With aging, the proportion of water in the human body declines and, as a result, the water reservoir is reduced and the safety margin for staying hydrated become smaller (34). Drinking 30 ml water per day per kg body mass (i.e. 6-8 glasses of water for the average adult) is required to prevent dehydration (18). Older people should increase their intake if they have fever or diarrhea, live in high environmental temperature or if there are drug- or caffeine-induced fluid losses (16). There is little information about the fluids intake by older Saudis. However, Hosa (2003) found that only 36% of females living in Riyadh drank more than 5 cups of water daily (20).

Nutritional status

Obesity and underweight

There were large variations in the mean of BMI and in the proportions of underweight and obese Saudi elderly (Table 5). Overweight and obesity are prevalent among free-living males and females from different geographical regions of Saudi Arabia whereas underweight is common among institutionalized older adults. For comparison, in the UK, it is estimated that one elderly person in seven has a medium or high risk of malnutrition when assessed using the malnutrition universal screening tool (MUST) (35) and morbidity and mortality are predicted by involuntary weight loss. Additionally, excess body weight (or high Body Mass Index (BMI)) is associated with increased health risks (16).

Iron deficiency anemia

Deficiencies of micronutrients including iron, iodine, zinc and vitamins A and D are highly prevalent in the Arab region but the magnitude of the problem differs from country to country (36). This review has revealed that iron and vitamin D status has been studied widely in Saudi Arabia. When using WHO criteria of anemia (Hb < 13g/l and Hb < 12g/l in men and women respectively), the prevalence of iron deficiency anemia in institutionalized men and women in Riyadh was 40% and 32.2% respectively (37, 38). The prevalence of anemia among women living in institutions in Jeddah (32.5%) was very similar (21). As expected, using a lower cut-off point for anemia (Hb< 11 g/dl), revealed a much lower overall prevalence (12.9%) of anemia in free-living people with a higher prevalence in females (18%) compared with males (5%) (39).

Vitamin D status

The most widely used marker of Vitamin D status is plasma 25 hydroxyvitamin D (25 OHD) concentration

Table 4
Micronutrient intakes of Saudi older adults

City/ region	Sample size and gender	Age group	Living situation	Demographic data	Dietary assessment method	Dietary intakes: Mean intake/day (unit)	Dietary intakes: Deficient nutrients [a] (% of participants with low intake)	Dietary intakes: Nutrients of high intake [b]	reference
Riyadh city/central region	25 female	Mean age 58±1.33	Free-living	68% were illiterate	24 h recall	Calcium 742 (mg) Phosphates 1000 (mg) Sodium 2122.3 (mg) Potassium 1799.8 (mg)			(29)
Riyadh city/ Central region	88 male	≥60 Years old	institutionalized		3 day food record	Vitamin B12 3.5 (μg) Folate 249 (μg)	Vitamin B12** (34.1%) Folate (88.6%)		(33)
Different geographical sectors of Jeddah city/ Western region	707 urban elderly female	>50 years old	Free-living	41.7% were illiterate 48.9% their monthly income below 5000 SR	Food frequency questionnaire	Calcium 523 (mg)			(47)
Jeddah city/western region	61 female	Mean age 53±0.59	Free-living	44% were highly educated	Food frequency questionnaire	Calcium 732.5 (mg) Vitamin D 0.71 (μg)	Calcium*** (59%) Vitamin D (100%)		(28)
Jeddah city/ western region	103 male	≥50 years old	Free-living	56% had low socioeconomic status	Food frequency questionnaire	Selenium 42.0 (μg) Copper 1.25 (mg) Zinc 8.75 (mg) Vitamin E 12.5 (mg) Vitamin A 734.5 (μg) Vitamin C 41.8 (mg)	Selenium *** (87%) Vitamin A (54%) Vitamin E (29%) Vitamin C (32%) Zinc (34%) copper		(27)
Different institutions in Jeddah city/ western region	200 urban elderly female	55->75 Years old	institionalized	39% were widows 68.5% were illiterate 91% their income is financial aid.	24hour recall for 7 days	Calcium 418.27 (mg) Iron 3.70 (mg) Zinc 5.96 (mg) Vitamin A 395.12 (μg) Vitamin D 1.52(μg) Vitamin E 11.47 (mg) Vitamin C14.83(mg) Folate 141.66 (μg) Niacin 9.13 (mg)	Calcium* Iron Vitamin A Vitamin D Vitamin C Folate niacin		(21)
Northern region	404 male	88% of the sample were 60-70 years old	Free-living	78.2% were illiterate 81.2% had monthly income below 3000 SR.	24-hour recall		Vitamin A* Vitamin C Vitamin D Vitamin B6	Vitamin B12* Selenium Zinc	(19)

(a) Mean intake of nutrients are below different recommendation, (b) mean intake of nutrients are above different recommendations; * Nutrients below or above RDA (1989),**nutrients intake below or above DRI,***nutrients below or above EAR

Table 5
Mean BMI and prevalence of underweight and obesity in Saudi older adults

City/ region	Sample size and gender	Age group	Living situation	Demographic data	Results a BMI in Kg/m2 (mean±SD)	reference % underweight	% overweight	% obesity	
All five administrative regions of Saudi Arabia	2135 urban and rural male and female	>50 years	Free-living				36.7	26.3	(82)
All five administrative regions of Saudi Arabia	1962 male 1947 male 1522 female 994 female (urban and rural)	50-59 60-70 50-59 60-70	Free-living				42.5 41.6 31.8 34.0	27.8 22.1 45.9 39.0	(83)
Riyadh city/central region	25 female	Mean age 58±1.33	Free-living	68% were illiterate	34.0 ± 1.14				(29)
Riyadh city/ central region	32 female	>50 years old	Free-living		30.8 ± 5.8				(48)
Riyadh city/ Central region	88 male	≥60 Years old	institutionalized		28.8 ± 3.4				(33)
Riyadh city/central region	45 male	60-80 years old	institutionalized		24.2 ± 0.85	11.1	22.2	13.3	(38)
Riyadh city/ Central region	50 male	50-85 years old	institutionalized	84.8% were illiterate 63.6% were not married	23.15 ± 3.54	30.61*		4.08*	(30)
Riyadh city/ central region	31 female	>60 years old	institionalized			16.1	25.8	12.9	(37)
Different geographical sectors of Jeddah city/ Western region	707 urban elderly female	>50 years old	Free-living	41.7% were illiterate 48.9% their monthly income below 5000 SR	32.7 ± 6.6				(47)
Different geographical sectors of Jeddah city/ Western region	568 elderly female	Mean age 62.38± 8.34	Free-living		31.63 ± 6.07				(46)
Different geographical sectors of Jeddah city/ Western region	671 elderly female	Mean age 58.68± 7.46	Free-living	55.2 % had monthly income of less than 5000 SR	31.7 ± 5.8				(84)
Jeddah city/western region	61 female	Mean age 53±0.59	Free-living	44% were highly educated	34.33 ± 0.68		20	80	(28)
Jeddah city/ western region	103 male	≥50 years old	Free-living	56% had low socioeconomic status	28.8 ± 0.5		37	38	(27)
Different geographical sectors of Jeddah city/ western region	284 elderly male	Mean age 56.9 ± 6.3	Free-living	39.1% had monthly income of less than 5000 SR	29.2 ± 5.2				(42)
Different institutions in Jeddah city/ western region	200 urban elderly female	55->75 years old	Institionalized	39% were widows 68.5% were illiterate 91% their income is financial aid	27.47 ± 7.60	18**	22	35	(21)
Northern region	404 male	88% of the sample were 60-70 years old	Free-living	78.2% were illiterate 81.2% had monthly income below 3000 SR		4*	66.6*		(19)

BMI classification: underweight (BMI <18.5 kg/m2), overweight (BMI ≥25-<30 kg/m2), obesity (BMI ≥30 kg/m2); *cutoff points are not identified in the abstract of the theses.** underweight categorized as BMI <20 kg/m2; BMI: body mass index.

(40). Decreased vitamin D intake and decreased cutaneous synthesis contribute to increased risk of vitamin D deficiency among older people (41). Although Saudi Arabia is a sunny country, direct exposure to sunlight is restricted for cultural reasons and/or due to excessive heat (42, 43) and so cutaneous vitamin D synthesis may be relatively low. Serum 25OHD concentrations decreased significantly with age in both genders living in Jeddah city (western region). In men aged (<50 years), mean serum 25 OHD (nmol/l) was 31.3 and declined to 26.84 in older adults (>50 years) (42). Similarly, mean serum 25 OHD (nmol/l) fell from 43 nmol/l to 33.3 nmol/l in pre-menopausal and post-menopausal women, respectively (40). In Al-Khobar city (eastern region), the proportions of older men with deficient (< 50 nmol/l) and insufficient (>50 - ≤ 75 nmol/l) serum 25 OHD were 12% and 25% (44). These proportions were higher for women living in the same city, where the proportions were 19% and 36% for deficiency and insufficiency, respectively (45). Other studies conducted on females living in Riyadh and Jeddah city showed mean serum 25 OHD concentrations ranging from 28.6 to 55.8 nmol/l (29, 46, 47, 48). These results highlight that both vitamin D insufficiency and deficiency are quite common in Saudi older adults.

Physical Activity status

Regardless of age, gender, stage of life or socioeconomic status, physical activity (PA) has been demonstrated to benefit all people (16) and the PA recommendations for adults are also applicable for older adults. It is recommended that adults should achieve at least 30 minutes moderate intensity PA per day on at least 5 days per week. This can be achieved by lifestyle-based activities such as brisk walking or climbing stairs as well as through structured exercise or sport. In addition, older people are encouraged to do specific activities that improve and promote coordination, strength and balance (49). The WHO's global strategy on diet, PA and health recommends that individuals should engage in different types and amounts of PA to benefit many different aspects of health. For example, at least half an hour of regular, moderate intensity PA on most days reduces the risk of colon cancer, breast cancer, diabetes and cardiovascular disease (50).

A national epidemiological health survey in Saudi Arabia between 1995 and 2000 recruited 17,395 Saudi males and females aged between 30 and 70 years. Survey participants were classified into active and inactive categories based on the intensity, duration and frequency of PA. Findings showed that both sexes were predominantly inactive and that females were significantly more inactive (98.1%) than males (93.9%). Inactivity increased with age in males - the proportion of inactive young males (30-39 years) was 89.5% and this rose significantly to 97.4% in older adult males (60-70 years) (51). In another study conducted in Riyadh city, inactivity also increased with age reaching 57% in those aged 60 years and above (52). This highlights the sedentary nature of the adult Saudi population (51, 52, 53).

Discussion

This article focuses on reviewing the dietary patterns, nutrient intakes, and nutritional and PA status of older adults living in Saudi Arabia. In addition, it examines the geographical differences in such patterns and identifies research gaps in respect of nutrition and PA for this population group.

Gender differences

This review has found that older Saudi males are more likely than females to consume 3 main meals/day with reportedly greater preferences for healthy foods (i.e. fish, vegetables, fresh fruits and grilled meats). In addition, consumption of fruits and vegetables by females was well below the recommended five servings per day. This gender effect is in contrast with the situation in some other countries. For example, older Canadian females ate more meals per day (2.9) than males (2.8) and had higher dietary knowledge and dietary attitude scores (54). In UK, older males have been reported to consume fewer servings of fruit and vegetables daily than older females (55).

Surprisingly, given their lower body weights, intakes of total energy, carbohydrates, proteins and fats (including different types of fatty acids) were slightly higher in females than in males living in Jeddah city. These results are in contrast with findings from older Americans where total energy intake of women are significantly lower than of men (56). It is possible that under-reporting of dietary intake is more commonr for men than for women in Saudi Arabia because the former have less responsibility for, and familiarity with, food preparation. Low intakes of micronutrients such as zinc, selenium, iron, copper, vitamins A, C, E and B6 and folic acid (which influence immune system) are common in aged populations (57). In Saudi Arabia, intakes of folate, vitamin A, D and C were lower than recommendations and low intakes were common in both genders.

Whilst the large majority of older Saudi adults of both genders were inactive, the proportion of those inactive was higher among females. Similarly, Sun et al (2013) reported that older age groups from several countries including USA, Australia, Canada, UK, China and Brazil were less likely than the younger groups to be regularly active, and females were less likely than males to undertake regular PA (58).

Influence of Geography

Eastern coastal region residents consume more fish and, therefore, more omega-3 fatty acids than residents in the internal region of Saudi Arabia. This influence of geographical location on fish consumption were also reported by Torres et al (2000) who found that daily fish consumption was ten-fold greater in fishing village residents than in rural village residents in Portugal (59). Eating fish (particularly fatty fish) at least two times (two servings) per week is recommended by the American Heart Association (60). Recent studies showed that higher fish intake is associated with slower cognitive decline (61), less severe depressive symptoms (62) and may protect against bone loss in older people (63).

Regarding micronutrients intake, vitamin A and C intakes were reported to be lower than recommendations in Saudis living in the western and northern regions. Similar low intakes of vitamins were found in older persons living in rural villages in the Philippines (64). In Egypt, vitamin A was one of the least adequately supplied nutrients in the diets of the elderly (65). On the other hand, intakes above the recommendations for vitamin B12, selenium and zinc were found in males living in the northern region of Saudi Arabia.

Obesity and overweight were common in older adults living in different regions of the country. High rates of overweight and obesity are also common in other countries in the eastern Mediterranean Region (EMR) (including Gulf Cooperation Council countries) with alarming levels of obesity in all age groups (66, 67). When using BMI or waist-to-hip ratio as indicators of obesity, the prevalence of obesity in EMR is one of the highest in the world (68). Two-thirds to three-quarters of adults in Kuwait, Qatar, Saudi Arabia and Bahrain are overweight and obese (67). Overweight and obesity are strongly associated with higher risk of several chronic non-communicable diseases including cardiovascular diseases, coronary heart disease, type 2 diabetes mellitus, hypertension, metabolic syndrome, non-alcoholic steato-hepatitis and certain cancers all of which are critical health problems in the gulf region (67). Ng et al (2011) proposed that possible determinants of such rapid growth in obesity in this region are: frequent snacking, fast-food and soft drink consumption, low fruit and vegetable intakes which together may contribute to increased energy intake. The growth of fast-food restaurants, supermarkets and hypermarkets are also another reason for this trend. Moreover, most adults in the gulf region are physically inactive (67) which exacerbates the effects of higher energy intakes on obesity risk.

In addition to obesity, vitamin D deficiency and insufficiency were prevalent in older adults living in different regions of Saudi Arabia. Although hypovitaminosis D is common world-wide, it is more common and more severe in older adults (69). A recent review showed that older people from the Middle East/Africa region had significantly lowered 25 OHD values than children and adolescents (70). Low circulating concentrations of 25 OHD in older adults are associated with reduced mobility, increased risk for falls and fractures, and with increased risk of death from cardiovascular disease (69, 71). The decline in Vitamin D status in older adults could be explained by several factors. First, the decreased capacity of older skin to synthesize previtamin D3 from its precursor (7-dehydrocholesterol) (69, 72). Second, age-related renal impairment may decrease the renal hydroxylation of 25-hydroxyvitamin D to active 1,25 dihydroxyvitamin D (57). Third, loss of mobility, and being home-bound, restricts exposure to sunlight (69, 72). Fourth, loss of appetite, financial problems and less efficient absorption of dietary vitamin D contribute to inadequate vitamin D uptake (69). Last, medications used commonly by older adults, including barbiturates, cholestyramine, phenytoin and laxatives, may interfere with vitamin D metabolism (72). Whilst all of these factors are likely to explain some of the prevalence of low vitamin D status of older Saudi adults, inadequate sunlight exposure (for cultural and climatic reasons) may also be an important determinant.

Living conditions – free-living v. those in institutions:

Institutionalized males showed higher energy intakes than institutionalized females. Women living in institutions reported lower daily intake of fat, protein and carbohydrates compared with free-living women. In Egyptian elderly living in Alexandria city, total daily energy intake was below the recommendations for both institutionalized and free-living subjects, with higher intakes among institutionalized than free-living individuals (65). Low intake of dietary fiber and folate were found in institutionalized, compared with free-living, Saudis. Inadequate folate intake was reported in institutionalized Spanish elderly (73) and low intake of all nutrients, except for iron and carbohydrates, was reported in elderly people living in nursing homes in Iran (74). Some of these differences between institutionalized and free-living people may be explained by the fact that those who were institutionalized were more frail, less healthy and/or older than their free-living comparators.

Compared with free-living individuals, underweight was more common in institutionalized older adults where the prevalence of underweight (BMI< 18.5 Kg/m2) ranged from 11% to 30%. Among institutionalized Malaysian elderly, the percentage of underweight was 17% while it reaches 62% in older adults resident in the Emirates (75, 76).

Iron deficiency anemia was more common in institutionalized compared with free-living Saudis. This is similar to findings from a study of American elderly, where 4% of free-living males and 8% of free-living females but 40% of institutionalized elderly had iron deficiency anemia (77). Other studies have shown that 25% and 66% of institutionalized older adults in Spain

and United Arab of Emirates, respectively were anemic (73, 76). In addition to inadequate iron intake, major causes of iron deficiency anemia in older adults include gastrointestinal blood loss, peptic ulcers, usage of drugs causing gastrointestinal bleeding (e.g. aspirin and other non-steroidal anti-inflammatory drugs), hematuria and hemorrhoids (78).

Temporal changes

The studies referred to above were largely cross-sectional studies comparing free-living with institutionalized older people. A stronger study design is to compare intakes of the same older people before and after institutionalization. There have been relatively few such studies in Saudi Arabia but these have shown that daily consumption of the 3 main meals and snack meals declined in females after institutionalization. In addition, the frequency of consumption of whole wheat bread, sweets, fresh vegetables, red meats, poultry, shrimp, egg and legumes decreased while consumption of white bread, pasta, biscuits, pastries, full fat fermented milk (laban) and powdered milk increased. Changes in eating habits among nursing home residents were reported by Clarke and Wakefield (1975) (79).

Research gaps

Lifestyle factors, notably diet and PA, are important determinants of health and wellbeing at all stages of the life-course. These factors are especially important in older age when better lifestyle behaviors are associated with lower risk of age-related frailty, disability and disease (80, 81). To date, surveys of the eating patterns, nutritional status and PA of older Saudis have been patchy and unsystematic. In addition, the interpretation of the findings is hampered by the lack of population-representative sampling frames and the use of heterogeneous data collection tools. More systematic studies which sample those living in different regions of the country are needed and, in particular, there is limited information on the dietary intake or nutritional status of older adults living in the southern region of Saudi Arabia. Social, behavioural and financial factors influencing malnutrition, food and nutrient intake and status and physical inactivity status in this population are also needed. Such systematic studies are essential to facilitate objective assessment of these important lifestyle-related factors and to inform public health policies.

Ethical Standards: No ethics is required.

Conflicts of Interest: None.

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