**Supplemental File 1**. Adjustment of food and beverage consumption after adjustment of indirectly estimated energy intake

In the diet history questionnaire used in this study, there were insufficient data on all types of food and beverages to allow us to calculate total energy intake. We used a non-optimal method for indirect estimation of energy intake and energy-adjusted estimates. We assumed a stable weight for respondents and estimated energy consumption based on a combination of resting metabolic rate (RMR), energy expenditure for activity, and thermogenic effect of foods. We used the Mifflin-St Jeor equation to calculate RMR(1):

Men: RMR = 9.99\*weight (kg) + 6.25\*height (cm) + 4.92\*age (year) + 5

Women: RMR=9.99\*weight (kg) + 6.25\*height (cm) + 4.92\*age (year) -161

Respondents were asked to report the frequency and duration of the types of vigorous and moderate occupational, house, or recreational activities they that engaged in, as well as time spent walking and sitting. More details are available elsewhere with regard to physical activity in this survey.(2) We calculated the Metabolic Equivalent (MET) for the activities in a typical day for each respondent, and used the following formula to estimate Energy Expenditure for physical Activity (EEA)(3,4):

EEA=

Finally, total energy expenditures (TEE) were estimated through summation of RMR and energy expenditures for activity, considering 10% thermogenic effect of food (TEF) processing(5):

TEE= RMR+EEA+TEF≈

We excluded those who had a TEE of more than the 99th percentile or less than the first percentile for each sex.

TEE was estimated 2,333 kcal/day (SE=10) for all Saudi adults, 2,624 kcal/day (SE=15) for men, and 2,030 kcal/day (SE=11) for women. Energy expenditure for activities was 24.5% (SE=0.2) of TEE for men and 21.6% (SE=0.2) for women. Table 1 of Supplemental File 1 shows the energy-adjusted consumption of food and beverage consumption.

After energy adjustment (to 2,000 kcal/day), consumption of most of the food or beverage items was higher in females than males (Supplemental File 1, Table 2); energy-adjusted red meat consumption was still higher in men than women.

Estimated total energy consumptions were 2,324 kcal/day (SE=20) in 15-24 year old, 2,420 kcal/day (SE=16) in 25-39 year old, 2,290 kcal/day (SE=15) in 40-59 year old and 2,147 kcal/day (SE=32) in individuals aged 60 years or more. Table 3 of Supplemental File 1 shows the energy-adjusted consumption of foods and beverages in different age groups. After energy adjustment, the consumption of processed meat and SSB was still higher in younger individuals, while consumption of fruits and vegetables was lower.

Overall, estimated total energy consumption was 2,246 kcal/day (SE=18) in individuals with primary school or less education, 2,359 kcal/day (SE=15) in individuals who had completed elementary or high school educations, and 2,377 kcal/day (SE=21) in individuals with college or higher education. Table 4 of Supplemental File 1 shows consumption in the groups with different educational achievement after energy adjustment. After energy adjustment, the consumption of fruits, juices, all fishes, shrimp, and labneh was higher in people with college or higher education, compared to other two groups with lower education.

Estimated total energy consumption was 2,247 kcal/day (SE=18) in individuals with incomes less than 5,000 Riyals (1 Saudi Riyal=0.27 US Dollar), while consumption was 2,374 kcal/day (SE=16) in individuals with incomes from 5,000-14,999 Riyals, and 2,475 (SE=32) kcal/day in individuals with incomes of at least 15,000 Riyals. (See Table 5 of Supplemental File 1 for energy-adjusted consumption of food and beverages in different income groups).

**References of Supplemental File 1:**

1. Frankenfield D, Roth-Yousey L, Compher C, et al. (2005) Comparison of predictive equations for resting metabolic rate in healthy nonobese and obese adults: a systematic review. *J. Am. Diet. Assoc.* **105**, 775–789.

2. El Bcheraoui C, Tuffaha M, Daoud F, et al. (2016) On Your Mark, Get Set, Go: Levels of Physical Activity in the Kingdom of Saudi Arabia, 2013. *J. Phys. Act. Health* **13**.

3. Craig CL, Marshall AL, Sjöström M, et al. (2003) International physical activity questionnaire: 12-country reliability and validity. *Med. Sci. Sports Exerc.* **35**, 1381–1395.

4. Mahabir S, Baer DJ, Giffen C, et al. (2006) Comparison of energy expenditure estimates from 4 physical activity questionnaires with doubly labeled water estimates in postmenopausal women. *Am. J. Clin. Nutr.* **84**, 230–236.

5. Willett W (2012) *Nutritional epidemiology.* Oxford University Press.

Table 1. Average energy-adjusted (to 2,000 kcal/day) daily food and beverage consumption in Saudi adults (2013)

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Food/beverage type | | N | n | Weight/Volume units | | Serving sizes | |
| Mean | SE | Mean | SE |
| Fruit | | 10187 | 9672 | 64.1 g | 1.3 | 0.610 | 0.012 |
| Vegetables | | 10334 | 9743 | 103.0 g | 2.2 | 1.000 | 0.021 |
| Pure juice | | 10066 | 9475 | 27.7 ml | 0.8 | 0.234 | 0.007 |
| Dark fishes | | 10096 | 9516 | 10.4 g | 0.3 | 0.122 | 0.003 |
| Other fishes | | 10082 | 9489 | 12.6 g | 0.3 | 0.145 | 0.003 |
| Shrimp | | 9801 | 9337 | 2.0 g | 0.1 | 0.024 | 0.001 |
| Red meat | | 10223 | 9745 | 39.3 g | 0.7 | 0.462 | 0.008 |
| Poultry meat | | 10336 | 9833 | 95.0 g | 1.8 | 1.203 | 0.023 |
| Processed meat | | 9667 | 9206 | 4.0 g | 0.2 | 0.058 | 0.003 |
| Other processed food | | 9664 | 9193 | 86.2 g | 2.5 | 0.216 | 0.006 |
| Eggs | | 10219 | 9708 | 41.1 g | 0.6 | 0.447 | 0.007 |
| Nuts | | 9768 | 9288 | 9.6 g | 0.2 | 0.239 | 0.006 |
| Yogurt | | 10257 | 9706 | 69.2 g | 2.1 | 0.395 | 0.012 |
| Milk | | 10326 | 9805 | 203.9 ml | 5.3 | 0.822 | 0.022 |
| Laban | | 10269 | 9753 | 107.0 g | 2.8 | 0.611 | 0.016 |
| Labneh | | 9866 | 9380 | 26.3 g | 0.8 | 0.150 | 0.005 |
| Cheese | | 10113 | 9594 | 40.8 g | 0.9 | 0.816 | 0.019 |
| SSB | | 9967 | 9476 | 101.0 ml | 2.5 | 0.808 | 0.020 |
|  |

Table 2. Energy-adjusted (to 2,000 kcal/day) daily food and beverage consumption in Saudi male and female adults (2013)

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Food items | Male (N=5253) | | | | Female (N=5482) | | | |
| Energy-adjusted (g or ml units) | | Energy-adjusted serving sizes | | Energy-adjusted (g or ml units) | | Energy-adjusted serving sizes | |
| Mean | SE | Mean | SE | Mean | SE | Mean | SE |
| Fruit | 60.2 g | 1.6 | 0.574 | 0.015 | 68.1 g | 2.0 | 0.649 | 0.019 |
| Vegetables | 84.1 g | 1.8 | 0.817 | 0.018 | 122.8 g | 4.0 | 1.192 | 0.039 |
| Pure juice | 25.7 ml | 1.1 | 0.217 | 0.009 | 29.8 ml | 1.3 | 0.251 | 0.011 |
| Dark fishes | 9.1 g | 0.3 | 0.107 | 0.004 | 11.8 g | 0.4 | 0.138 | 0.005 |
| Other fishes | 11.5 g | 0.4 | 0.133 | 0.004 | 13.8 g | 0.5 | 0.158 | 0.006 |
| Shrimp | 1.8 g | 0.1 | 0.021 | 0.001 | 2.3 g | 0.2 | 0.027 | 0.002 |
| Red meat | 41.9 g | 1.0 | 0.493 | 0.011 | 36.5 g | 1.0 | 0.430 | 0.012 |
| Poultry meat | 85.9 g | 2.0 | 1.087 | 0.026 | 104.6 g | 3.1 | 1.324 | 0.040 |
| Processed meat | 3.7 g | 0.3 | 0.053 | 0.004 | 4.4 g | 0.3 | 0.064 | 0.004 |
| Other processed food | 85.4 g | 3.7 | 0.214 | 0.009 | 87.1 g | 3.4 | 0.218 | 0.009 |
| Eggs | 39.4 g | 0.8 | 0.429 | 0.009 | 42.9 g | 1.0 | 0.466 | 0.011 |
| Nuts | 8.6 g | 0.3 | 0.215 | 0.007 | 10.6 g | 0.4 | 0.266 | 0.009 |
| Yogurt | 53.5 g | 1.5 | 0.305 | 0.009 | 86.0 g | 3.9 | 0.492 | 0.022 |
| Milk | 175.6 ml | 5.5 | 0.708 | 0.022 | 233.9 ml | 9.4 | 0.943 | 0.038 |
| Laban | 98.9 g | 3.4 | 0.565 | 0.020 | 115.6 g | 4.5 | 0.661 | 0.025 |
| Labneh | 22.0 g | 1.0 | 0.126 | 0.005 | 30.9 g | 1.3 | 0.177 | 0.007 |
| Cheese | 32.8 g | 1.1 | 0.656 | 0.021 | 49.4 g | 1.6 | 0.987 | 0.031 |
| SSB | 99.5 ml | 2.7 | 0.796 | 0.022 | 102.6 ml | 4.2 | 0.821 | 0.034 |

Table 3. Energy-adjusted (to 2,000 kcal/day) daily food and beverage consumption in Saudi adults by age group (2013)

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Food items | Energy-adjusted (to 2,000 kcal/day) | | | | | | | |
| 15-24 years (N=2382) | | 25-39 years (N=4026) | | 40-59 years (N=3070) | | 60 years or more (N=1257) | |
| Mean | SE | Mean | SE | Mean | SE | Mean | SE |
| Fruit (g) | 52.5 | 1.9 | 66.3 | 2.3 | 78.5 | 3.0 | 74.3 | 4.6 |
| Vegetables (g) | 97.4 | 4.4 | 102.8 | 3.1 | 111.5 | 3.6 | 109.1 | 6.4 |
| Pure juice (ml) | 24.9 | 1.6 | 30.4 | 1.2 | 30.0 | 1.4 | 24.3 | 1.9 |
| Dark fishes (g) | 10.6 | 0.5 | 11.5 | 0.4 | 9.3 | 0.4 | 8.0 | 0.8 |
| Other fishes (g) | 11.7 | 0.6 | 13.7 | 0.5 | 13.3 | 0.5 | 10.9 | 0.8 |
| Shrimp (g) | 1.6 | 0.2 | 2.9 | 0.2 | 1.9 | 0.1 | 1.4 | 0.3 |
| Red meat (g) | 38.1 | 1.2 | 38.6 | 1.2 | 40.6 | 1.2 | 45.7 | 3.1 |
| Poultry meat (g) | 104.9 | 3.7 | 92.0 | 2.8 | 85.9 | 2.8 | 79.5 | 3.9 |
| Processed meat (g) | 5.5 | 0.4 | 4.0 | 0.2 | 2.3 | 0.2 | 1.3 | 0.4 |
| Other processed food (g) | 103.2 | 4.7 | 92.3 | 4.8 | 60.6 | 3.1 | 44.8 | 4.7 |
| Eggs (g) | 42.0 | 1.2 | 42.5 | 1.0 | 40.5 | 1.1 | 31.7 | 1.5 |
| Nuts (g) | 11.0 | 0.4 | 9.4 | 0.4 | 8.5 | 0.4 | 5.4 | 0.7 |
| Yogurt (g) | 63.4 | 3.6 | 70.7 | 3.9 | 74.2 | 3.5 | 81.3 | 7.2 |
| Milk (ml) | 206.4 | 10.9 | 198.1 | 8.0 | 199.3 | 7.7 | 230.5 | 13.3 |
| Laban (ml) | 95.2 | 4.8 | 110.8 | 5.1 | 118.6 | 5.1 | 123.5 | 7.6 |
| Labneh (g) | 25.6 | 1.6 | 25.2 | 1.0 | 29.6 | 1.5 | 23.7 | 2.2 |
| Cheese (g) | 44.8 | 1.9 | 42.0 | 1.5 | 35.8 | 1.3 | 28.0 | 1.9 |
| SSB (ml) | 144.7 | 5.0 | 94.2 | 3.6 | 52.2 | 2.6 | 26.0 | 2.5 |

Table 4. Energy-adjusted (to 2,000 kcal/day) daily food and beverage consumption in Saudi adults by educational level (2013)

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Food items | Energy-adjusted (to 2,000 kcal/day) | | | | | |
| Primary or less (N=3286) | | Elementary/ high school (N=4780) | | College or higher (N=2649) | |
| Mean | SE | Mean | SE | Mean | SE |
| Fruit (g) | 65.1 | 2.2 | 56.8 | 1.7 | 79.6 | 3.2 |
| Vegetables (g) | 101.8 | 4.2 | 101.0 | 3.4 | 109.4 | 3.5 |
| Pure juice (ml) | 23.5 | 1.4 | 25.8 | 1.3 | 37.1 | 1.6 |
| Dark fishes (g) | 10.1 | 0.5 | 10.0 | 0.4 | 11.7 | 0.5 |
| Other fishes (g) | 12.4 | 0.6 | 12.2 | 0.4 | 13.7 | 0.6 |
| Shrimp (g) | 1.1 | 0.2 | 1.9 | 0.1 | 3.5 | 0.3 |
| Red meat (g) | 39.3 | 1.3 | 39.7 | 1.0 | 38.4 | 1.3 |
| Poultry meat (g) | 95.5 | 3.4 | 98.0 | 2.8 | 88.0 | 3.7 |
| Processed meat (g) | 3.6 | 0.4 | 4.1 | 0.3 | 4.4 | 0.3 |
| Other processed food (g) | 65.2 | 3.7 | 91.8 | 3.6 | 98.1 | 6.2 |
| Eggs (g) | 35.9 | 1.1 | 42.2 | 0.9 | 44.7 | 1.3 |
| Nuts (g) | 10.3 | 0.6 | 9.2 | 0.3 | 9.6 | 0.4 |
| Yogurt (g) | 73.4 | 4.9 | 65.4 | 2.5 | 73.4 | 4.6 |
| Milk (ml) | 218.8 | 9.4 | 195.7 | 8.1 | 205.6 | 10.9 |
| Laban (ml) | 111.2 | 5.1 | 102.3 | 4.0 | 113.2 | 6.0 |
| Labneh (g) | 19.8 | 1.3 | 26.8 | 1.2 | 32.6 | 1.6 |
| Cheese (g) | 34.6 | 1.5 | 42.3 | 1.4 | 44.8 | 2.0 |
| SSB (ml) | 76.5 | 4.6 | 117.2 | 3.7 | 90.4 | 4.5 |

Table 5. Energy-adjusted daily food and beverage consumption in Saudi adults by income level (2013)

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Food items | Energy-adjusted (to 2,000 kcal/day) | | | | | |
| Less than 5,000 Riyals (N=3161) | | 5,000-14,999 Riyals (N=4549) | | 15,000 Riyals or more (N=1131) | |
| Mean | SE | Mean | SE | Mean | SE |
| Fruit (g) | 54.6 | 2.1 | 65.0 | 1.7 | 90.9 | 5.6 |
| Vegetables (g) | 100.1 | 4.2 | 96.4 | 2.4 | 122.1 | 5.9 |
| Pure juice (ml) | 23.5 | 1.6 | 30.4 | 1.4 | 38.0 | 2.4 |
| Dark fishes (g) | 10.3 | 0.5 | 10.3 | 0.4 | 11.6 | 0.9 |
| Other fishes (g) | 12.7 | 0.6 | 13.4 | 0.5 | 14.5 | 1.1 |
| Shrimp (g) | 1.7 | 0.2 | 2.2 | 0.1 | 3.2 | 0.3 |
| Red meat (g) | 34.4 | 1.3 | 39.0 | 1.0 | 45.6 | 2.5 |
| Poultry meat (g) | 97.0 | 4.1 | 87.0 | 2.1 | 102.9 | 5.0 |
| Processed meat (g) | 3.3 | 0.4 | 3.8 | 0.2 | 4.2 | 0.6 |
| Other processed food (g) | 95.2 | 4.8 | 84.7 | 4.0 | 83.7 | 7.2 |
| Eggs (g) | 39.5 | 1.2 | 43.1 | 1.0 | 42.6 | 2.1 |
| Nuts (g) | 7.9 | 0.4 | 9.5 | 0.3 | 10.8 | 0.7 |
| Yogurt (g) | 72.4 | 4.2 | 66.5 | 2.4 | 67.6 | 5.0 |
| Milk (ml) | 206.6 | 10.8 | 189.8 | 7.1 | 236.6 | 17.9 |
| Laban (ml) | 113.9 | 5.3 | 106.0 | 3.9 | 111.7 | 8.2 |
| Labneh (g) | 21.9 | 1.3 | 29.6 | 1.4 | 34.3 | 2.4 |
| Cheese (g) | 44.1 | 2.2 | 40.7 | 1.4 | 42.8 | 2.4 |
| SSB (ml) | 114.5 | 5.4 | 91.2 | 3.2 | 83.4 | 5.3 |