

Inadequacies of micronutrient intake in normal weight and overweight young adults (18-25 years): A cross-sectional study

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Table S1: Deficit in micronutrient intake in University students

Micronutrient	gap*	
	Males	Females
Folate (mg)	-	28.71
Vitamin D (μg)	5.6	4.96
Calcium (mg)	-	102.56
Magnesium (mg)	34.75	57.38
Iron (mg)	-	6.18
Potassium (mg)	783.78	1256
Selenium (mg)	14.57	19.3

*Deficit has been calculated in comparison with RNI

Highlights:

Males and females university students (18-25 years) have inadequate intakes of important vitamins and minerals, particularly Vitamin D.

Females seem to have more inadequacies in the diet compared to males with regards to calcium, iron and folate

Overweight and obese individuals have lower intakes of micronutrients compared to normal weight.

1 Abstract

2 Objectives: This study aims to assess adequacy in micronutrient intake in comparison with
3 reference nutrient intakes (RNI) and identify differences in intakes between normal weight
4 and overweight individuals.

5 Study design: A sample of 542 University students (18-25 years), normal weight (N=369)
6 and overweight (N=173) was included in a cross-sectional study.

7 Methods: A three-day diet diary was used to assess energy and nutrient intake. BMI and waist
8 circumference were measured.

9 Results: Mean dietary vitamin D intake was lower than RNI in both males (4.44 µg) and
10 females (5.04 µg). Mean intakes of calcium (597.44 mg), iron (8.62 mg) and folate (171.29
11 mg) were also lower than recommendations in females. Weight status (normal weight versus
12 overweight) was significantly associated with micronutrient intake and a trend towards a
13 decrease in vitamin and mineral intake with increasing weight was noted.

14 Conclusions: Results suggest the need to increase the intake of some micronutrients to meet
15 the RNI, in order to ensure optimal health. This study provides a helpful tool to reinforce
16 recommendations and potential health promotion and intervention strategies in University
17 settings, and could influence manufacturers involved in new food product development
18 targeted to this young population.

19
20 Introduction

21 There has been an increasing interest in micronutrient malnutrition due to its potential
22 contribution to global disease burden ¹. Deficiency in micronutrients can affect the immune
23 system, influence performance, impair development and cause metabolic disorders ^{1,2}.

24 Although acute micronutrient deficiency is more prevalent in developing countries, it remains
25 a public health issue in the Western countries ¹. This is mainly due to the increased

26 consumption of high-energy low-micronutrient foods. In Europe, deficiency in iron and
27 iodine have been identified as the most prevalent deficiencies in the adult population ¹.

28 Inadequate micronutrient consumption (particularly iron and folate) is more common in
29 young women in the Western world, due to increased requirements and poor intake ³.

30 Adolescents and young adults have been described as having poor diet choices that are
31 associated with obesity, meal skipping and snacking ⁴. In particular, University students are

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32 known to have a low diet quality characterised by a high consumption of convenience and
33 fast foods and a low intake of fruits of vegetables ⁵. This could have long-term effects on the
34 occurrence of cardiovascular diseases ⁶. Also, as lifestyle choices have been shown to affect
35 peak bone mass by 20-40% and increase osteoporosis risk later in life ⁷, a unhealthy diet
36 could significantly affect those who are still in the phase of bone growth . According to the
37 UK government, around half of the adult population go onto Higher Education ⁸; therefore,
38 identifying micronutrient inadequacies could help develop strategies tailored to this
39 population. Furthermore, it has been shown that obese individuals are at higher risk of
40 nutrient deficiencies compared to normal weight controls with similar age and sex ^{9,10}, yet
41 studies remain fairly limited and none have focused on this issue solely in young adults.
42 Therefore, the aim of this study is to identify the prevalence of micronutrient inadequacies in
43 a sample of 18-25-year-old University students in England and to identify differences in
44 micronutrient intake between BMI categories. This could help target future recommendations
45 and health intervention strategies in Universities, and provide a reference for developing new
46 food products/recipes tailored to young adults.

48 Methods

49 *Study Design and Participants*

50 After obtaining ethical approval, volunteers aged 18–25 years with no restriction to weight
51 status and gender were recruited by convenience sampling from Universities across the
52 Northwest of England between 2014 and 2016. Participants with known metabolic diseases
53 (diabetes, hypertension and/or cardiovascular diseases) were excluded from the study. The
54 study was conducted within the framework of the Collaborative Investigation on Nutritional
55 Status of Young Adults (CINSYA) in the city of Liverpool, UK. Data collection took place at
56 Liverpool Hope University health sciences Lab. The study is part of an ongoing project that
57 also aims to identify risk factors for diabetes and cardiovascular diseases in young adults.

58 All participants gave their written informed consent prior to participation. The study was
59 conducted in accordance with the Declaration of Helsinki, and the protocol was approved by
60 the Ethics Committee at Liverpool Hope University. Demographic data was collected.

62 *Anthropometric Measurements*

63 Participants height was measured in Frankfort Plane position using a SECA201 stadiometer
64 (SECA GMBH & Co, Hamburg, Germany) and weight was measured via Tanita MC-
65 180MA (Tokyo, Japan). Participants wore light clothing, and shoes and socks were removed
66 before stepping on the equipment). A BMI greater than or equal to 30 Kg/m² was identified
67 as obese, between 25 - 29.9 Kg/m² as overweight, while a BMI between 18-24.9 Kg/m² was
68 considered normal ¹¹. Waist circumference (WC) was measured at the midpoint between the
69 lowest rib and the top of the iliac crest ¹².

71 *Diet and Physical Activity*

72 A three-day (two weekdays and one weekend day) integrated diet and physical activity diary
73 was used to assess energy and nutrient intake. The diet diary was extracted from the validated
74 questionnaires of the UK's National diet and Nutrition survey (NDNS) with minimal
75 adjustments ¹³. To improve compliance and enhance accuracy, a completed example and food
76 portion pictures were supplied and prompts on time, place and portion sizes were shown in
77 the diet diary. The diaries were analysed for energy, macronutrients and micronutrients using
78 Microdiet dietary analysis software (Microdiet v3, Downlee Systems Ltd, Salford, UK). A
79 validated 3-day physical activity diary produced by Bouchard et al (1983) ¹⁴ was used to
80 assess physical activity. Participants reported physical activity for each 15-minute interval
81 over 3 days. The activities ranked from 1 to 9 (sedentary activity to high intensity), and the
82 analysed output of the diary produced total energy expenditure as kcal/kg/day and min/day
83 spent in light/moderate/vigorous activity¹⁴.

84 *Statistical analysis*

85 In order to reduce misreporting, participants with reported average energy intake lower than
86 800 Kcal or higher than 4200 Kcal were excluded. Data analysis was conducted using SPSS
87 version 24 for Windows (IBM SPSS, Inc., NY, USA). Data are expressed as mean (standard
88 deviation) (SD). The determination of sample size was originally based on its ability to
89 predict an 8% prevalence of metabolic syndrome in the population. However, this sample
90 will have 95% power to detect a vitamin inadequacy of 4% when compared to UK Reference
91 Nutrient Intakes (RNI). Difference between groups based on BMI status was assessed using
92 independent t-test. Pearson and Spearman product-moment correlations were used to
93 examine associations between selected variables. Significance was set at p<0.05.

94 **Results**

95 ***Participant characteristics***

96 After excluding outliers (N=23), 542 young adults were included in the analysis. Females
97 constituted 57% of the sample. Among participants, 86.5% were British and 14.6% were
98 smokers. Characteristics of the study population are presented in Table 1. Males reported
99 practicing an average of 5 hours of moderate to vigorous physical activity a week compared
100 to 3 hours for females (physical activity guidelines of 150 minutes of physical activity per
101 week for both genders¹⁵). BMI and WC followed a strong linear correlation ($r = 0.75$,
102 $p < 0.001$).

104 ***Macronutrient intake***

105 Compared to UK Dietary reference values (DRVs)¹⁶, mean carbohydrate intake was slightly
106 below the recommendations for both males (48% of daily energy intake) and females (49% of
107 daily energy intake). Mean fat intake met the recommendations of no more than 35% of daily
108 energy intake (33% for males and 35% for females), while mean saturated fat intake was
109 slightly above the recommendations of 11% for males (11.5%) and females (12%).

111 ***Vitamin and mineral intakes***

112 Assessment of diet diaries showed that the mean intakes of vitamin A, vitamin D,
113 magnesium, potassium, iodine and selenium were below the RNI recommendations for both
114 males and females (Table 2). Females also reported to have lower intakes of iron, folate and
115 calcium compared to RNI. For vitamin A, females reported to closely meet the RNI, whereas
116 males reported a lower intake of this vitamin. Iodine intake was also reported to be below the
117 RNI recommendations (Table 2). The deficit in micronutrient intake compared to RNI is
118 illustrated in (Supplementary data, Table S1). In addition, participants consumed sodium
119 above the recommendations (2971 mg for men and 2396 mg for women) (Table 2)

120 ***Effect of weight status***

121 In males, independent t-test showed a significant difference in levels of iodine and vitamin
122 B2 between participants with BMI $< 25 \text{ Kg/m}^2$ (normal) and BMI $> 25 \text{ Kg/m}^2$ (overweight).
123 Participants with normal BMI had a higher intake of iodine (80.44 (6.55) mg versus 59
124 (98.63) mg, $p = 0.03$), and vitamin B2 (0.76 (0.8) mg versus 0.69 (0.47) mg, $p = 0.03$)
125 compared to those who are overweight. In females, there were significant differences

126 between overweight and normal weight participants for levels of magnesium (87.69 (9.34)
127 mg versus 136 (9.29) mg, $p=0.03$, respectively), iron (3.9 (0.41) versus 4.6 (0.31) mg,
128 $p=0.059$, respectively) and selenium (22.4 (2.35) mg versus 31.74 (2.16), $p=0.056$,
129 respectively). No other significant differences were noted. However, there were no significant
130 differences in reported energy intake between normal weight and overweight in females
131 ($p=0.52$) or males ($p=0.71$). The comparison between overweight (BMI between 25-29.9
132 Kg/m^2) and obese (BMI > 30 Kg/m^2) participants did not identify significant differences in
133 micronutrient intakes with regards to all nutrients except for sodium which has been reported
134 to be consumed in higher amounts in overweight (3253 mg) compared to obese individuals
135 (2680 mg) ($p>0.05$).

136 Moreover, spearman's correlation showed negative associations between BMI status (normal
137 weight, overweight and obese) and calcium ($r=-0.13$, $p=0.05$), magnesium ($r=-0.13$, $p=0.05$),
138 and vitamin E (-0.17 , $p=0.01$) in the male population. In females, there was a negative
139 correlation between BMI status and sodium ($r= -0.13$, $p=0.02$), calcium (-0.18 , $p=0.002$),
140 magnesium ($r=-0.12$, $p=0.04$), Cu (-0.13 , $p=0.02$), iodine ($r= -0.14$, $p=0.016$) and vitamin B2
141 ($r= -0.16$, $p=0.006$). No other significant correlations were noted. However, there was a trend
142 towards a lower intake of micronutrient-dense foods with increasing BMI (Figure 1).

144 Discussion

145 This study aims to assess the micronutrient intake in the diet of young adults aged 18-25
146 years and identify whether weight status is associated with micronutrient intake; a
147 particularly important issue due to the continuous rise of obesity rates in all age categories¹⁷.
148 Comparing intakes to RNI and not LRNI (Lower Reference Nutrient Intake) was primarily to
149 assess adequacy of vitamin and mineral intake and reinforce recommendations that ensure
150 that the needs of nearly all the population are met and deficiencies are reduced.

151 *Micronutrient intake:* Both men and women reported lower dietary intakes of vitamin A,
152 vitamin D, magnesium, potassium, iodine and selenium compared to the relevant RNI.
153 Females also reported to have lower intakes of iron, folate and calcium compared to RNI
154 (Table 2). The low intakes of vitamin D in both groups constitute a serious issue because of
155 the critical role of vitamin D in musculoskeletal and cardiovascular disease^{18,19}. In fact, only
156 3% of this population reported an intake of vitamin D at the level of 10 $\mu\text{g/day}$. However, sun

157 exposure plays a substantial role in vitamin status and responsiveness to UV exposure largely
158 varies between individuals²⁰. Therefore, no conclusive evidence could be made without
159 biochemical assessment of vitamin D status. The low vitamin intake is yet consistent with
160 many studies undertaken in the UK in different age groups^{21,22}. Results are also consistent
161 with NDNS outcomes which reported low blood levels of Vitamin D in one fifth of adults
162 aged between 19-64 years²³. Despite the current recommendations on consuming vitamin D-
163 rich foods²⁴, the low intake in comparison with recommendations persists. . The Scientific
164 Advisory Committee on Nutrition (SACN) recommends that all adults consider taking a
165 vitamin D supplement, particularly during autumn and winter²⁵. This, along with potential
166 food fortification policies needs to be reinforced/considered for University students and
167 young adults.

168 For vitamin A, results are inconsistent with the NDNS results and potentially suggest that
169 young adults between 18-25 years might have lower intakes of vitamin A. A potential
170 explanation would be the lack of fruits and vegetables intake in the diet, which are a source of
171 beta-carotene. This suggests to reinforce recommendations in order to achieve adequate
172 intake. Additionally, assessment of iodine intake does not match with the NDNS results. The
173 latter also reported a normal urine iodine concentration in adults aged between 19-64 years.
174 Iodine deficiency constitute an important issue as it is linked to goitre and can cause adverse
175 effects on reproduction in adults²⁶. Therefore, further investigations in young adults are
176 needed, and studies analysing urinary iodine concentrations in a sample of young adults
177 along with dietary intake would help clarify the iodine status in this age category.

178 Iron intake was reported to be lower than the recommendations only in females (58% of RNI)
179 with a deficit of 6.18 mg compared to RNI (Tables 2 & 3). This deficit has shown to be
180 higher than the results obtained in the NDNS report for females aged 19-64 years (76% RNI).
181 Results nearly match with the EFSA (European food safety authority) report showing that
182 iron intake of European women aged 18-49 years is 9.8 (3.8) mg/day²⁷, which corresponds to
183 a mean deficit of 5 mg compared with the RNI. The low-quality diet of young university
184 students could have resulted in this iron deficit, yet testing indicators of iron status (Ferritin,
185 Haemoglobin) in conjunction with dietary intake would have provided a better overview of
186 iron status in this population. Consequences of low iron status have been well established.
187 Suboptimal iron status and anaemia are associated with weakness, reduced physical work
188 capacity and work tolerance²⁸⁻³⁰ and a potential deficit in cognitive function³¹. Therefore,
189 there is a need for developing strategies that aim to eliminate or reduce this deficiency.

190 In addition to iron, the average female diet seems to be inadequate in folate and calcium
191 (Table 2), the latter are known to play a significant role in reproduction, musculoskeletal
192 health, immunity and performance¹. Therefore, special attention needs to be provided to
193 these inadequacies. As folate fortification of flour is still under consideration in the UK³²,
194 results provide further supporting evidence for folate fortification of commonly consumed
195 foods. Furthermore, with the emergence of new food products, developing recipes enriched
196 with these nutrients and targeted to young females might be considered. Lastly, deficiencies
197 in magnesium, potassium, selenium and zinc are consistent with the results of NDNS for
198 Years 5 and 6 for the 19-64 age category. However, as limited evidence has been used to set
199 DRVs for the latter nutrients, data should be interpreted with caution²³.

200 Interestingly, although females reported more inadequacies in micronutrients than males and
201 commonly a higher deficit, the analysis of nutrient density per energy intake showed that
202 males have lower intakes per 1000 Kcal for most nutrients (with the exception of vitamins C
203 and E) (Table 2). Thus, although females' diet appears to be more deficient in nutrients
204 compared to men, it is more micronutrient-dense per Kcal consumed. Therefore, it can be
205 suggested that both men and women need diet improvement with regards to energy:
206 micronutrient ratio, yet the lower energy intake in women renders the micronutrient
207 deficiency more prominent. On the other hand, sodium consumption has been reported to be
208 above the recommendations of 1600 mg in both men and women, which is associated with
209 detrimental consequences on cardiovascular risk³³. However, sodium intake could be
210 imprecisely measured by dietary assessment. For a more accurate measure of dietary sodium
211 intake, 24 hour urinary sodium excretion could be assessed to better predict the degree of
212 sodium over-consumption. Recommendations need then to be reinforced to lower the intake
213 of high salt foods in this age group.

214 *Effect of weight status:* Results suggest a low micronutrient intake in overweight and obese
215 participants compared to normal weight participants for dietary intakes of magnesium (87.69
216 (9.34) mg versus 136 (9.29) mg, $p=0.03$, respectively), iron (3.9 (0.41) versus 4.6 (0.31) mg,
217 $p=0.059$, respectively) and selenium (22.4 (2.35) mg versus 31.74 (2.16), $p=0.056$,
218 respectively). Results match with previous studies showing that micronutrient intakes are
219 lower in the obese population compared to normal weight^{8,9}. It would have been valuable to
220 identify the types of foods consumed in this population that have contributed to these
221 differences. Future studies identifying this would be of interest. Interestingly, the non-
222 significant differences in reported energy intake between normal weight and overweight in

223 females ($p=0.52$) or males ($p=0.71$) could be mostly explained by underreporting which can
224 be affected by weight status. In fact, a study reported that in obese individuals, the reported
225 energy intake constituted an average of 59% of their energy expenditure³⁴. This suggests the
226 need for potential studies that validate energy intake particularly in obese individuals, and
227 possibly establish a correction factor to the self-reported energy intake. Diet could then be
228 more accurately assessed in future studies. The negative association between BMI status and
229 some micronutrients (calcium, magnesium, iron, iodine, vitamin E and vitamin B2) and the
230 trend towards a lower intake of micronutrient-dense foods with increasing BMI (Figure 1),
231 leads to the suggestion that the extra amount of energy consumed by participants in the
232 overweight population mostly involves low-nutrient dense foods.

233 Results of this study are useful to assess dietary micronutrient inadequacy in this group of the
234 population and identify the nutrient deficit that would help reinforce recommendations and
235 strategies specific to this age and demographic group. Given the large number of University
236 students in UK higher education, developing health promotion and intervention strategies
237 need to be considered in University settings. As there are some gaps with regards to
238 fortification¹, this study provides further guidance on evidence-based food fortification and
239 food product development that could cover the deficit for most nutrients without risks of
240 excesses and improve the diet without major changes in dietary patterns. A national survey
241 reported that pizza, pasta and curry are among the top consumed foods for those aged
242 between 16-20 years old in the UK³⁵. Furthermore, another survey including 2573 students
243 in UK universities reported that the price is the main determinant when buying foods³⁶.
244 Therefore, these factors need to be taken into account in any practical recommendations or
245 actions.

246 **Limitations**

247 The study presents limitations with regards to misreporting dietary intake, which is a
248 drawback for all methods assessing diet in a free-living population. However, efforts have
249 been made to limit misreporting by including a visual guide to portion sizes for participants
250 and excluding those with particularly high or low reported energy intake. Using weighed food
251 records may have helped to reduce the bias although this method also has limitations. The use
252 of the 3-day diet diary can also present limitations in assessing typical diet of participants, yet
253 a similar protocol (i.e. the use of three productive days out of completed 4 day-diet diary) was
254 used in NDNS survey. In addition, the lack of biochemical tests did not provide a more

255 accurate index of micronutrient status. Moreover, the assessment of type of food intake in
256 conjunction with micronutrient intake would have been valuable in assessing how dietary
257 habits can affect nutrient intake. Lastly, the limitations of the diet analysis software used did
258 not allow to explore the correlation between other diet components (such as free sugars and
259 fibre intake) and micronutrient ingestion.

260

261 **Conclusion**

262 This study shows that the diet of University students aged 18-25 years is below
263 recommendations for vitamin D in both genders and for calcium, folate and iron in females.
264 Overweight and obese individuals seemed to have higher inadequacies compared to normal
265 weight. Therefore, there is a need to improve health by reducing vitamin and mineral
266 deficiencies through education to emphasize nutritional recommendations, reinforcement of
267 health intervention strategies and utilisation of potential food fortification/enrichment or
268 targeted supplementation. This will help to ensure optimal health and avoid negative long-
269 term consequences in this young adult population.

270

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274

275 **Transparency declaration**

276 The lead author affirms that this manuscript is an honest, accurate, and transparent account of
277 the study being reported. The reporting of this work is compliant with STROBE guidelines.
278 The lead author affirms that no important aspects of the study have been omitted and that any
279 discrepancies from the study as planned.

280

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Table 1: Characteristics of the overall population of young adults

	Mean (SD)	
	Males (N=232)	Females (N=310)
Age (years)	21.07 (1.4)	20.7 (1.5)
Physical activity (hours/day)	5	3
BMI (Kg/m ²)	24.52 (3.85)	23.84 (4.32)
Waist circumference (cm)	84.53 (10.4)	77.3 (11.5)

Table 2: Micronutrient intake with comparison to UK Reference nutrient intake in University students (18-25 years).

Micronutrients	Average intake/ day	Males (N=232)			Females (N=310)			
		RNI ¹	% RNI	Nutrient density intake (per 1000 Kcal) ²	Average intake/ day	RNI ¹	%RNI	Nutrient density intake (per 1000 Kcal)
<i>Vitamins</i>								
Vitamin A (µg)	590	600	84	120	568	600	95	277
Thiamin (mg)	1.48	1	148	0.67	1.17	0.8	146	0.66
Riboflavin (mg)	1.48	1.3	114	0.29	1.12	1.1	102	0.68
Niacin (mg)	28.17	17	166	9.66	18.04	13	139	12.67
Vitamin B6 (mg)	2.01	1.4	144	0.81	1.57	1.2	131	0.87
Folate (mg)	220.4	200	110	80.74	171.29	200	86	79.79
VitaminB12 (µg)	4.1	1.5	273	0.79	3.01	1.5	201	1.88
Vitamin C (mg)	68	40	170	57	69.83	40	175	22
Vitamin D (µg)	4.44	10	44	0.28	5.04	10	50	1.04
Vitamin E (mg) ³	6.1	-	-	5.04	5.0	-	-	4.46
<i>Minerals</i>								
Calcium (mg)	729.46	700	104	225	597.44	700	85	327
Phosphorus (mg)	3818.67	550	694	1149	2253.9	550	410	1407
Magnesium (mg)	265.25	300	88	94	212.62	270	79	158
Iron (mg)	11.43	8.7	131	5	8.62	14.8	58	5.49
Zinc (mg)	9.33	9.5	98	3.85	6.74	7	96	5.25
Potassium (mg)	2716.22	3500	78	1149	2243	3500	64	1407
Iodine (mg)	110.55	140	79	14.67	82.7	140	59	58.4
Copper (mg)	1.24	1.2	103	0.47	1.3	1.2	108	0.94
Selenium (mg)	60.43	75	81	20.91	40.7	60	68	31.79
Na (mg)	2970.76	1600	186	1562	2395.46	1600	150	1964

RNI: Reference nutrient intake

¹RNI are the recommended nutrient intakes for the UK population.

²Nutrient density intake is the amount of nutrients consumed per 1000 Kcal.

³The RNIs for Vitamin E have not been set, therefore the percentage of RNI has not been calculated.

Table 3: Micro nutrient intake-related differences in different weight categories.

Males (N=232)			Females (N=310)		
Micronutrients		Daily intake Mean (SD)	Test of significance (Two-sided)	Daily intake Mean (SD)	Test of significance (Two-sided)
Vitamins					
Vitamin A (µg)	Normal weight ¹	640 (755)	0.26	591 (511)	0.28
	Overweight	522 (509)		555 (667)	
	Obese	421 (354)		426 (380)	
Thiamin (mg)	Normal weight	1.54 (0.74)	0.16	1.2 (0.62)	0.23
	Overweight	1.4 (0.51)		1.05 (0.49)	
	Obese	1.27 (0.84)		1.18 (0.53)	
Riboflavin (mg)	Normal weight	1.55 (0.86)	0.1	1.16 (0.69)	0.09
	Overweight	1.38 (0.61)		0.94 (0.5)	
	Obese	1.2 (0.72)		1.19 (1.11)	
Niacin (mg)	Normal weight	29.15 (16.93)	0.3	18.09 (9.16)	0.62
	Overweight	28.88 (12.86)		17.24 (9.06)	
	Obese	23.54 (11.98)		19.23 (9.76)	
Vitamin B6 (mg)	Normal weight	2.11 (1.01)	0.39	1.59 (0.83)	0.64
	Overweight	2.05 (0.79)		1.48 (0.74)	
	Obese	1.8 (0.96)		1.6 (0.66)	
Folate (mg)	Normal weight	233 (137)	0.1	177 (95)	0.63
	Overweight	214 (112)		163 (121)	
	Obese	170 (103)		173 (90)	
Vitamin B12 (µg)	Normal weight	4.24 (3.02)	0.56	3.11 (2.25)	0.28
	Overweight	4.17 (2.8)		2.59 (2.6)	
	Obese	3.5 (2.44)		3.2 (2.69)	
Vitamin C (mg)	Normal weight	69.83 (58.24)	0.15	74.22 (56.33)	0.12
	Overweight	70.7 (64.73)		57.34 (52.66)	
	Obese	129 (378)		70.85 (54.99)	
Vitamin D (µg)	Normal weight	4.74 (7.38)	0.82	5.42 (10.59)	0.33
	Overweight	4.11 (5.12)		3.32 (7.4)	
	Obese	4.96 (8.2)		5.75 (11.63)	
Vitamin E (mg)	Normal weight	6.39 (3.29)	0.11	5.16 (3.2)	0.15
	Overweight	5.8 (3.53)		4.3 (2.49)	
	Obese	4.83 (3.99)		5.08 (2.86)	
Minerals					
Calcium (mg)	Normal weight	742 (332)	0.23	619 (311)	0.15
	Overweight	749 (514)		523 (258)	
	Obese	588 (486)		589 (593)	
Phosphorus (mg)	Normal weight	2919 (1688)	0.3	2294 (995)	0.49
	Overweight	2703 (9820)		2115 (1089)	
	Obese	2404 (1786)		2244 (1134)	
Magnesium (mg)	Normal weight	273 (114)	0.06	223 (136)	0.06
	Overweight	268 (140)		180 (840)	
	Obese	205 (120)		205 (94)	
Iron (mg)	Normal weight	11.65 (5.37)	0.26	8.93 (4.61)	0.04 *
	Overweight	11.56 (5.96)		7.35 (3.47)	
	Obese	9.52 (5.86)		8.97 (4.51)	
Zinc (mg)	Normal weight	9.6 (5.34)	0.09	6.8 (3.06)	0.05
	Overweight	9.46 (4.93)		6.03 (2.88)	
	Obese	6.96 (4.34)		7.75 (4.57)	
Potassium (mg)	Normal weight	2765 (1038)	0.36	2294 (995)	0.62
	Overweight	2870 (1591)		2148 (1068)	
	Obese	2404 (1786)		2244 (1134)	
Iodine (mg)	Normal weight	119 (80.4)	0.07	88.02 (66.44)	0.27
	Overweight	105 (60.47)		71.72 (48.05)	
	Obese	81.3 (52.31)		87.14 (118.47)	
Copper (mg)	Normal weight	1.27 (0.82)	0.26	1.47 (684)	0.71
	Overweight	1.28 (0.85)		0.87 (0.67)	
	Obese	0.97 (0.63)		0.9 (0.47)	
Selenium (mg)	Normal weight	60.43 (44.11)	0.74	42.78 (31.74)	0.11
	Overweight	62.61 (33.86)		33.82 (19.59)	
	Obese	54.55 (31.8)		39.67 (27.2)	
Na (mg)	Normal weight	2954 (1189)	0.2	2478 (1337)	0.11
	Overweight	3253 (1843)		2302 (1049)	
	Obese	2680 (966)		1985 (1108)	