Association of Vitamin D Concentration with Subjective Health Complaints in Children and Adolescents: The CASPIAN-V Study

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Abstract

Background: Vitamin D deficiency (VDD) is recognized as a pandemic across the world. Identification, any association between VDD and subjective health complaints (SHC), can be helpful to realize critical mechanisms and improve psychological and somatic symptoms. However, studies are limited. The purpose of the present study was to examine the associations between VDD and SHC in children and adolescents.

Study design: cross-sectional study

Methods: In this national study, 2594 Iranian children and adolescents aged 8 to 18 years were included. Data on SHC, anthropometric indices, physical activity, and serum levels of vitamin D were collected. Logistic regression models (crude, adjusted) were applied to examine any links between VDD and SHC. Statistical analysis was performed using STATA software version 11. P-values< 0.05 were considered as statistically significant.

Results: Among SHC, irritability (40.9%) and feeling anxiety (33.7%) were the most prevalent ones. Multiple complaints in students with VDD was 2.5 times greater than those with sufficient vitamin D concentrations (p<0.001). Compare to the reference group, the strongest association was found between vitamin D status and difficulties in getting to sleep (OR: 2.5, 95%CI: 1.18, 3.53, p<0.001).

Conclusion: Serum levels of vitamin D in approximately 70% of Iranian children and adolescents were lower than 30 ng/mL. However, no significant differences were found between gender groups. In addition, there were significant associations between vitamin D status and the most somatic and psychological symptoms, particularly for getting to sleep. It seems national interventional programs for vitamin D supplementation or food fortifications can be helpful.

Background

In the 21st century, vitamin D deficiency (VDD) is recognized as a pandemic compared to other micronutrient deficiencies (1). It has been estimated that more than 1 billion people across the world suffer from VDD. The prevalence of VDD in all age groups and both genders are remarkably increasing even in areas with sufficient sunlight, including the Middle East countries and North Africa (2). Vitamin D status varies among societies and it depends on different factors including skin color, genetics, body weight, diet, geographical regions, and other environmental factors (3, 4).

Based on scientific evidence, vitamin D, a fat-soluble vitamin, play pivotal roles in health maintenance (5). Not only does vitamin D contribute to calcium homeostasis and bone health, but also it involves controlling metabolic parameters including blood pressure, glucose levels, as well as the modulation of inflammatory parameters and immunity (2, 6). Besides, vitamin D levels can affect psychological health and behavioral factors (7, 8). Earlier studies indicated that VDD could increase the rate of depression and anxiety in both children and adolescents (8, 9). However, findings are inconsistent.

Recently, limited studies investigated the associations between Vitamin D status and any Subjective health complaints (SHC), and some showed considerable links (7, 8, 10, 11). SHC is a complex of somatic (e.g., headache, stomachache) and psychological (e.g., feeling nervous, depression) symptoms that cannot be justified by an underlying sickness (12, 13). It can also reflect the key dimensions of wellbeing. Health complaints are prevalent in children and adolescents, especially in girls and more than one symptom maybe reported at the same time by an individual (14, 15). Health complaints can be associated with taking medicine, using primary care services, and absenteeism from schools (16).

Identification, any association between the serum levels of vitamin D and SHC, can be helpful to realize critical mechanisms in the expression of psychological and somatic symptoms as well as healing the severity of such health discomforts in school-age children using effective interventions. Although the impacts of vitamin D deficiency on physical and psychological health parameters have been examined in several studies, little is known in children, and adolescents regarding on this. Due to limited studies and the importance of clarification this issue, the primary purpose of the current study was to examine the association between VDD and SHC in children and adolescents.

Methods

Study design and participants

The present national cross-sectional study is a part of the fifth survey of Childhood and Adolescence Surveillance and Prevention of Adult Non-communicable disease (CASPIAN)-V study in Iran (2014–2015). Details of the study protocol have been published earlier (17). Briefly, in the CASPIAN-V study, 14,400 students from both urban and rural regions (30 provinces) were selected using a multistage, stratified cluster sampling method in winter. In each province, considering the eligible criteria, sampling was conducted proportionally based on gender (boy, girl), the level of education (primary and secondary), and the place of residence (urban or rural).

Only children and adolescents who met the following criteria were included: (i) primary and secondary students, (ii) having Iranian nationality, and (iii) children and adolescents without any chronic diseases.

In each province, considering the eligible criteria sampling was conducted based on gender (boy, girl), the level of education (primary and secondary), and the place of residence (urban or rural).

For biochemical measurements, 14 clusters (each cluster included 10 subjects) in each province were randomly chosen for biochemical analyses, and for this study, 2594 blood samples were selected for the assessment of serum Vitamin D concentrations.

Notably, after explaining the study procedures and its objectives, verbal and written informed consent was obtained from students and their parents. The Ethics committee of Isfahan University of Medical Sciences approved the protocol of the current study (Project number: 194049).

Assessments

In the present study, the information about students' basal characteristics, socio-economic status, screen time, anthropometric indices, physical activity, as well as SHC were collected.

Students' basal characteristics

We used the questionnaire provided by the World Health Organization-Global School Student Health Survey (WHO-GSHS) to assess health behaviors and protective parameters related to the leading causes of morbidity and mortality of children and adolescents (18). The validity and reliability of the Farsi format of the questionnaire were acceptable, as was identified earlier (Cronbach's alpha coefficient: 0.97, Pearson's correlation coefficient: 0.94) (19).

Socio-economic status

To estimate the SES of each student, five main parameters including parent's education and occupation, type of children's school (public, private), home-ownership (yes, no), and family assets (having a personal computer, vehicle ownership) were considered. Finally, SES score was calculated as the weighted average of the mentioned items. Students were then classified into three groups (low, medium, and high SES).

Screen time (ST)

To examine ST, participants were asked regarding the average time (hour/day) dedicated to watching TV and playing video games. After the calculation of total ST, students were classified into two groups (low and high). Those with less or equal to 2 hours per day were placed in low; otherwise they were considered as individuals with high ST.

Physical activity

A 7-day self-administrative physical activity questionnaire (PAQ-A) was used to examine the levels of physical activity. The PAQ-A is a valid and reliable questionnaire based on the information obtained previously (Cronbach's alpha coefficient: 0.97, Pearson's correlation coefficient: 0.94) (20).

Anthropometric measurements

Body weight and the height of students were measured with standard methods by a trained health care member of the team as described before (17). Body mass index (BMI) was calculated by dividing weight (kg) to the square of height (m).

SHC

To assess SHC, a valid questionnaire designed in the Health Behavior in School-aged Children (HBSC) study was applied (21). Using a face-to-face interview with students, the questionnaire was fulfilled. Participants were asked if they had experienced either any psychological (feeling low, feeling nervous, difficulty in getting sleep, and irritability) or somatic symptoms (stomach ache, headache, backache, feeling dizzy) in the last six months before the study. The frequency of each sign was asked, as well.

Response options for each symptom were as follows: (i) about every day, (ii) more than once a week, (iii) about every week, (iv) about every month, (v) and (vi) rarely or never. Finally, the responses were categorized as “weekly or more” and “rarely or never.”

Biochemical assessments

To assess the serum levels of 1,25 (OH) D3, 6 mL of venous blood samples was taken from students. All samples were stored at -70°C until biochemical analysis.

To measure the serum concentration of 25-hydroxy vitamin D,a direct competitive immunoassay chemiluminescent method with LIASON 25-OH vitamin D assay TOTAL (DiaSorin, Inc.) was used(coefficient of variation: 9.8%).

Serum levels of vitamin D lower than 10 ng/mL (deficient), between 10 and 30 ng/mL (insufficient), and greater than 30 ng/mL (sufficient) were considered as deficient, insufficient, and sufficient, respectively.

Statistical analysis

Qualitative and quantitative variables were expressed as number (percent) and Mean± Standard Deviation, respectively. Characteristics of students (age, location, SES, physical activity, ST) and vitamin D levels in each gender were provided, separately. The frequency of each health compliant as well as multiple complaints considering genders was reported in number and percentage. To assess the associations between vitamin D status and SHC, students were classified into three groups based on vitamin D concentrations (sufficient, insufficient, and deficient). The link between vitamin D status and SHC (8 health complaints) were examined across the mentioned three categories. In addition, the links that experienced multiple complaints were reported as well. Subjects with the sufficient levels of vitamin D3 (30- 50 ng/mL) were considered as a reference group, and the two remaining groups (deficient, insufficient categories) were compared with this one for each SHC. Logistic regression models, both crude and adjusted models (3 models), were applied to examine any links. Covariates such as age, sex, region, SES, physical activity, ST, and BMI were adjusted in the mentioned adjusted models. Model 4 was controlled for all the variables above. Statistical analysis was performed using STATA software version 11. P-values less than 0.05 were considered as statistically significant.

Results

Participants characteristics

In total, 2596 students (1166 girls, 1430 boys) were included. The mean age of participants was 12.1± 3.0 years, and most participants (71.3%) were from urban regions. As represented in **Table 1,** all general characteristics of students except ST and the location of living (urban, rural) were significantly different between boys and girls. Only in 29.0% of participants sufficient vitamin D was observed. There were no differences in vitamin D concentrations between boys and girls (p=0.18) (**Table 1**).

Frequency of SHC

As presented in **Figure 1**, the most prevalent health compliant was irritability (40.9%), which was followed by feeling anxiety (33.7%). Approximately 42.6% of participants, experienced two or more complaints throughout the last 6 months (**Figure 1**).

Table 2 shows the frequency of SHC in each gender category. A comparison of boys with girls revealed that in all complaints except feeling dizziness ($p<0.001$), no significant differences existed. Girls more than boys experienced dizziness (9.4 vs.5.8%) in the last 6 months. In addition, no significant differences were found in the frequency of boys and girls with multiple health complaints ($p=0.27$).

Frequency of SHC in Vitamin D categories

As provided in **Table 3,** the frequency of subjects with all somatic and psychological symptoms except stomachache ($p=0.05$) were significantly different among vitamin D categories. The occurrence of all remaining complaint except feeling dizziness in the deficient category was greater than insufficient and sufficient groups. The frequency of feeling dizziness in those with the serum levels of vitamin D between 10 and 30 ng/mL (8.5%) was higher than the other two categories. The frequency of subjects with multiple health complaints in subjects with VDD (55.8%) was greater than the other two groups as well.

The association between VDD and SHC

Multivariable-adjusted odds ratios (OR) for VDD and each health complaint has been reported in **Table 4**. As defined, sufficient vitamin D category was considered as a reference group and the other two groups were compared with this one. Both crude (model 1) and adjusted models (models 2-4) are provided in **Table 4**.

In crude models, children and adolescents with VDD experienced all complaints except feeling dizziness (OR: 1.27, 95%CI: 0.71, 2.26, $p=0.41$) more than those with the sufficient levels of vitamin D. After controlling confounders including age, gender, physical activity, ST, and BMI all links remained significant. In addition, reporting multiple complaints in students with VDD was 2.5 times greater than those with sufficient vitamin D concentrations ($p<0.001$). Compare to the reference group, the strongest association was found between vitamin D status (VDD) and difficulties in getting to sleep. No considerable changes were observed after controlling confounders (OR: 2.5, 95%CI: 1.18, 3.53, $p<0.001$).

Comparison students with the insufficient levels of vitamin D to those with sufficient levels showed positive significant association between insufficiency of vitamin D with headache, feeling dizzy, irritability, and difficulties in getting to sleep. After controlling confounders, the link between headache and vitamin D status disappeared ($p=0.12$). Similar to the VDD category, the strongest relationship was observed between difficulties in getting to sleep and insufficient levels of vitamin D. However, in this category, the link was weaker than the VDD category (OR: 1.53 vs. 2.53).

Discussion

Based on the current cross-sectional study, the serum levels of vitamin D in approximately 70% of Iranian children and adolescents were lower than 30 ng/mL. In addition, there were significant associations between vitamin D status and the most somatic and psychological symptoms in school-age children. Among SHC items, difficulties in getting to sleep showed the strongest link with VDD and the insufficient levels of vitamin D compared to sufficient levels.

A systematic review and meta-analysis (2018) on Iranian studies revealed that35% and 61% of Iranian boys and girls suffered from VDD, respectively. Based on their estimation, the prevalence of vitamin D insufficiency in Iranian children and adolescents was 31% (22). Turer et al. indicated that the prevalence of VDD (defined as 25-hydroxyvitamin-D <20 ng/mL) in healthy-weight and obese American children aged 6 to 18 years old were 21 and 34%, respectively(23). Al-Shaikh et al. reported that 95.3% of Saudi children (6-15 years old) had either Vitamin D insufficiency (49.9%) or VDD (45.5%) (24). According to the study by Shin et al., vitamin D insufficiency or VDD was found in 98.9 % of Korean boys and 100 % of girls(25). Sahu et al. also revealed that despite much sunlight in India, VDD (< 50 nmol/L) in Indian adolescent girls was 88.6% (26). Differences in the cut-off points for vitamin D status, age range, seasonal variation, genetic, geographical, and environmental differences can affect findings.

To the best of our knowledge, the present study is the first national research in developing countries that examined the links between vitamin D status and SHC in children and adolescents.

In the present study, 55.8% of subjects with VDD reported multiple health complaints. Irritability (47.8%), feeling nervous (43.9%), and difficulties in getting to sleep (33.6%) were the most frequent complaints among the study population. Our findings were in line with Ataie et al. study. They reported that some psychological distress, including anxiety, anger, depression, poor quality sleep, and worry were linked with hypovitaminosis D in Iranian adolescents(27).

Pathways through which vitamin D affects mental health have not been fully understood, yet. However, some possible mechanisms have been proposed. Vitamin D is a neurosteroid hormone that can regulate the metabolism of neurotransmitters in the central nervous system(28). Vitamin D can affect monoamine neurotransmitters, including norepinephrine and serotonin that play remarkable roles in depression and mood disorders (29, 30). In addition, in the central nervous system, vitamin D receptors, 25(OH) D 1-α-hydroxylase, and the cytochrome P-450 that catalyze the hydroxylation of calcidiol to calcitriol, the active form of vitamin D, have been reported (31).

Furthermore, studies on sleep–wake regulation and vitamin D target neurons showed positive impacts of vitamin D on sleep (32). In a systematic review and meta-analysis, Gao et al. showed that VDD increased sleep disorders by 50%. Serum levels of 25(OH) D less than 20 ng/mL can enhance the risk for unhealthy sleep. They also revealed that VDD was linked with poor sleep quality and short sleep duration (33). Vitamin D receptors are existed in the central nervous system and their distribution in several parts of the

brain including the hypothalamus, midbrain central gray, and prefrontal cortex are likely to affect sleep regulation (33).

The present study had some limitations that should be addressed. Firstly, due to the cross-sectional design of the study, we could not clarify any cause and effect relationships between vitamin D status and SHC. Secondly, we did not consider dietary intake and taking vitamin D supplement in the study population. Thirdly, genetic assessments such as the determination of polymorphisms were not performed. However, the present study seems to be the first national study in this topic and it provides a ground for interventional studies through the identification of VDD and SHC prevalence among school-age children. The results are helpful for both policymakers and clinicians and they clarified the necessity of national interventional programs for vitamin D supplementation or food fortifications with vitamin D in Iran.

Conclusions

Serum levels of vitamin D in approximately 70% of Iranian children and adolescents (7-18 years old) were lower than 30 ng/mL. However, no significant differences were found between gender groups. In addition, there were significant associations between vitamin D status and the most somatic and psychological symptoms. Among SHC items, difficulties in getting to sleep showed the strongest link with vitamin status. VDD increased the experience of difficulties in getting to sleep by 2.5 times compared to a sufficient level. However, prospective cohort studies considering genetic differences, dietary habits, taking supplements, and direct exposure to sunlight are suggested for the future to clarify a casualty link between VDD and SHC in Iranian children and adolescents.

Abbreviations

Body mass index: BMI

Childhood and Adolescence Surveillance and Prevention of Adult Non-communicable disease: CASPIAN

Health Behavior in School-aged Children: HBSC

Physical activity questionnaire: PAQ

Screen time: ST

Subjective health complaints: SHC

Vitamin D deficiency: VDD

World Health Organization-Global School Student Health Survey: WHO-GSHS

Declarations

Ethical Approval and Consent to participate: The study was approved by the Research and Ethics Council of Isfahan University of Medical Sciences. Written consent was obtained from study participants and their parents.

Consent for publication: Yes

Availability of supporting data: They are available and can be provided with reasonable reason. However, the dataset supporting the conclusions of this article will not be shared publicly, to ensure participants' privacy

Competing interests: The authors declare that they have no competing interests.

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Authors' contributions: M.Q, R.K, and R.H conceived of the presented idea. M.E, and G.SH developed the theory and arrange the sampling processes. M.Q, M.M, and M.A entered data and performed statistical analysis. N.N interpreted results and wrote the paper. All authors critically review the paper, did any necessary changes, and approved it.

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Authors' information: All authors are working as a professor or researcher at university and research centers.

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Tables

Table 1- General characteristics and vitamin D status in the study population (n= 2596)

Variables	Gender		P-value*
	Girl n (%)	Boy n (%)	
Age (years)			
7-12	672(57.6)	748(52.3)	0.007
13-18	494(42.4)	682(47.7)	
Location			
Urban	828(71)	1022(71.5)	0.798
Rural	338(29)	408(28.5)	
Socioeconomic status			
Poor	403(36.6)	405(29.4)	<0.001
Good	331(30.1)	496(36)	
Well	366(33.3)	477(34.6)	
Physical activity			
High	461(39.7)	647(45.4)	0.004
Low	699(60.3)	777(54.6)	
Screen time			
≤2 hours	985(86.4)	1179(84.8)	0.242
>2 hours	155(13.6)	212(15.2)	
Vitamin D Status (ng/mL)			0.182
<10	132 (11.3)	142 (9.9)	
10-30	682 (58.5)	886 (62.0)	
>30	352 (30.2)	402 (28.1)	

Table 2- The frequency of subjective health complaints based on gender

		Gender		P-value*
		Girl	Boy	
Headache n (%)	Yes	309 (26.5)	348 (24.4)	0.206
	No	856 (73.5)	1081 (75.6)	
Stomach ache n (%)	Yes	201 (17.3)	242 (17.0)	0.868
	No	964 (82.7)	1181 (83.0)	
Backache n (%)	Yes	163 (14.1)	192 (13.7)	0.805
	No	996 (85.9)	1207 (86.3)	
Feeling dizzy n (%)	Yes	109 (9.4)	81 (5.8)	< 0.001
	No	1046 (90.6)	1326 (94.2)	
Feeling low n (%)	Yes	131 (11.3)	156 (11.1)	0.872
	No	1027 (88.7)	1248 (88.9)	
Irritability n (%)	Yes	465 (40.1)	587 (41.6)	0.435
	No	696 (59.9)	825 (58.4)	
Feeling nervous n (%)	Yes	402 (34.6)	463 (32.9)	0.346
	No	759	946	

		(65.4)	(67.1)	
Difficulties in getting to sleep n (%)	Yes	278 (24.0)	311 (22.1)	0.259
	No	881 (76.0)	1096 (77.9)	
Multiple health complaints n (%)	Yes	511 (43.8)	596 (41.7)	0.271
	No	655 (56.2)	834 (58.3)	

*Chi square

Table 3- Frequency of each subjective health complaints in each vitamin D classifications

Variables		Vitamin D status			
		Deficient	Insufficient	Sufficient	P value*
Headache n (%)	Yes	88 (32.1)	404 (25.8)	165 (21.9)	0.003
	No	186 (67.9)	1163 (74.2)	588 (78.1)	
Stomachache n (%)	Yes	57 20.8	275 17.6	111 14.8	0.054
	No	217 (79.2)	1287 (82.4)	641 (85.2)	
Backache n (%)	Yes	55 20.4	213 13.8	87 11.7	0.002
	No	214 79.6	1331 86.2	658 88.3	
Feeling dizzy n (%)	Yes	18 (6.7)	132 (8.5)	40 (5.4)	0.025
	No	249 (93.3)	1419 (91.5)	704 (94.6)	
Feeling low n (%)	Yes	42 (15.5)	179 (11.6)	66 (8.9)	0.010
	No	229 (84.5)	1368 (88.4)	678 (91.1)	
Irritability n (%)	Yes	130 (47.8)	660 (42.6)	262 (34.9)	<0.001
	No	142 (52.2)	891 (57.4)	488 (65.1)	
Feeling nervous n (%)	Yes	118 (43.9)	519 (33.4)	228 (30.6)	<0.001

	No	151 (56.1)	1036 (66.6)	518 (69.4)	
Difficulties in getting to sleep n (%)	Yes	91 (33.6)	367 (23.7)	131 17.5%	<0.001
	No	180 (66.4)	1179 (76.3)	618 (82.5)	
Multiple health complaints n (%)	Yes	153 (55.8)	697 (44.5)	257 (34.1)	<0.001
	No	121 (44.2)	871 (55.5)	497 (65.9)	
*Chi square					

Table 4- The associations between subjective health complaints with vitamin D status

	Variables	Vitamin D level				
		Sufficient (reference)	Deficient OR (95% CI)	P-value*	insufficient OR (95% CI)	P-value*
Headache	Model 1	1	1.686 (1.241-2.291)	0.001	1.238 (1.007-1.522)	0.043
	Model 2	1	1.667 (1.226-2.268)	0.001	1.240 (1.008-1.526)	0.042
	Model 3	1	1.636 (1.186-2.256)	0.003	1.182 (0.953-1.464)	0.128
	Model 4	1	1.653 (1.197-2.282)	0.002	1.183 (0.955-1.467)	0.124
Stomachache	Model 1	1	1.517 (1.064-2.162)	0.021	1.234 (0.971-1.568)	0.086
	Model 2	1	1.510 (1.059-2.154)	0.023	1.236 (0.972-1.572)	0.084
	Model 3	1	1.626 (1.127-2.347)	0.009	1.189 (0.928-1.525)	0.171
	Model 4	1	1.646 (1.139-2.377)	0.008	1.191 (0.929-1.528)	0.167
Backache	Model 1	1	1.944 (1.341-2.818)	<0.001	1.210 (0.927-1.580)	0.160
	Model 2	1	1.936 (1.334-2.811)	0.001	1.213 (0.928-1.584)	0.157
	Model 3	1	2.016 (1.359-2.991)	<0.001	1.209 (0.914-1.599)	0.184
	Model 4	1	2.038 (1.373-3.025)	<0.001	1.211 (0.916-1.603)	0.179
Feeling dizzy	Model 1	1	1.272	0.412	1.637	0.008

			(0.716-2.260)		(1.136-2.359)	
	Model 2	1	1.269 (0.713-2.261)	0.418	1.682 (1.166-2.428)	0.005
	Model 3	1	1.432 (0.785-2.610)	0.242	1.849 (1.262-2.709)	0.002
	Model 4	1	1.455 (0.797-2.655)	0.222	1.850 (1.263-2.710)	0.002
Feeling low	Model 1	1	1.884 (1.244-2.853)	0.003	1.344 (0.999-1.809)	0.051
	Model 2	1	1.852 (1.220-2.814)	0.004	1.341 (0.995-1.808)	0.054
	Model 3	1	1.931 (1.240-3.007)	0.004	1.323 (0.967-1.810)	0.080
	Model 4	1	2.006 (1.285-3.131)	0.002	1.332 (0.973-1.822)	0.073
Irritability	Model 1	1	1.705 (1.287-2.259)	<0.001	1.380 (1.152-1.653)	<0.001
	Model 2	1	1.701 (1.282-2.257)	<0.001	1.381 (1.151-1.656)	<0.001
	Model 3	1	1.695 (1.259-2.282)	0.001	1.341 (1.109-1.622)	0.002
	Model 4	1	1.727 (1.282-2.328)	<0.001	1.346 (1.113-1.628)	0.002
Feeling nervous	Model 1	1	1.775 (1.333-2.365)	<0.001	1.138 (0.943-1.374)	0.177
	Model 2	1	1.761 (1.320-2.349)	<0.001	1.139 (0.943-1.376)	0.176
	Model 3	1	1.682 (1.242-2.278)	0.001	1.148 (0.942-1.399)	0.172

	Model 4	1	1.729 (1.275-2.344)	<0.001	1.153 (0.945-1.405)	0.160
Difficulties in getting to sleep	Model 1	1	2.385 (1.741-3.267)	<0.001	1.468 (1.176-1.833)	0.001
	Model 2	1	2.362 (1.722-3.239)	<0.001	1.470 (1.176-1.837)	0.001
	Model 3	1	2.516 (1.803-3.512)	<0.001	1.535 (1.213-1.942)	<0.001
	Model 4	1	2.532 (1.813-3.537)	<0.001	1.536 (1.214-1.944)	<0.001
Multiple complaints	Model 1	1	2.445 (1.844-3.242)	<0.001	1.548 (1.292-1.854)	<0.001
	Model 2	1	2.436 (1.834-3.236)	<0.001	1.559 (1.300-1.870)	<0.001
	Model 3	1	2.526 (1.875-3.402)	<0.001	1.577 (1.304-1.907)	<0.001
	Model 4	1	2.557 (1.897-3.447)	<0.001	1.580 (1.307-1.911)	<0.001

*Logistic Regression; OR: Odd Ratio; CI: Confidence Intervals

Model 1: Crude; Model 2: adjusted for age, sex and residential region; Model 3: Model 2+ socio-economical status, physical activity, and screen time; Model 4: Model 3+ body mass index

Figures

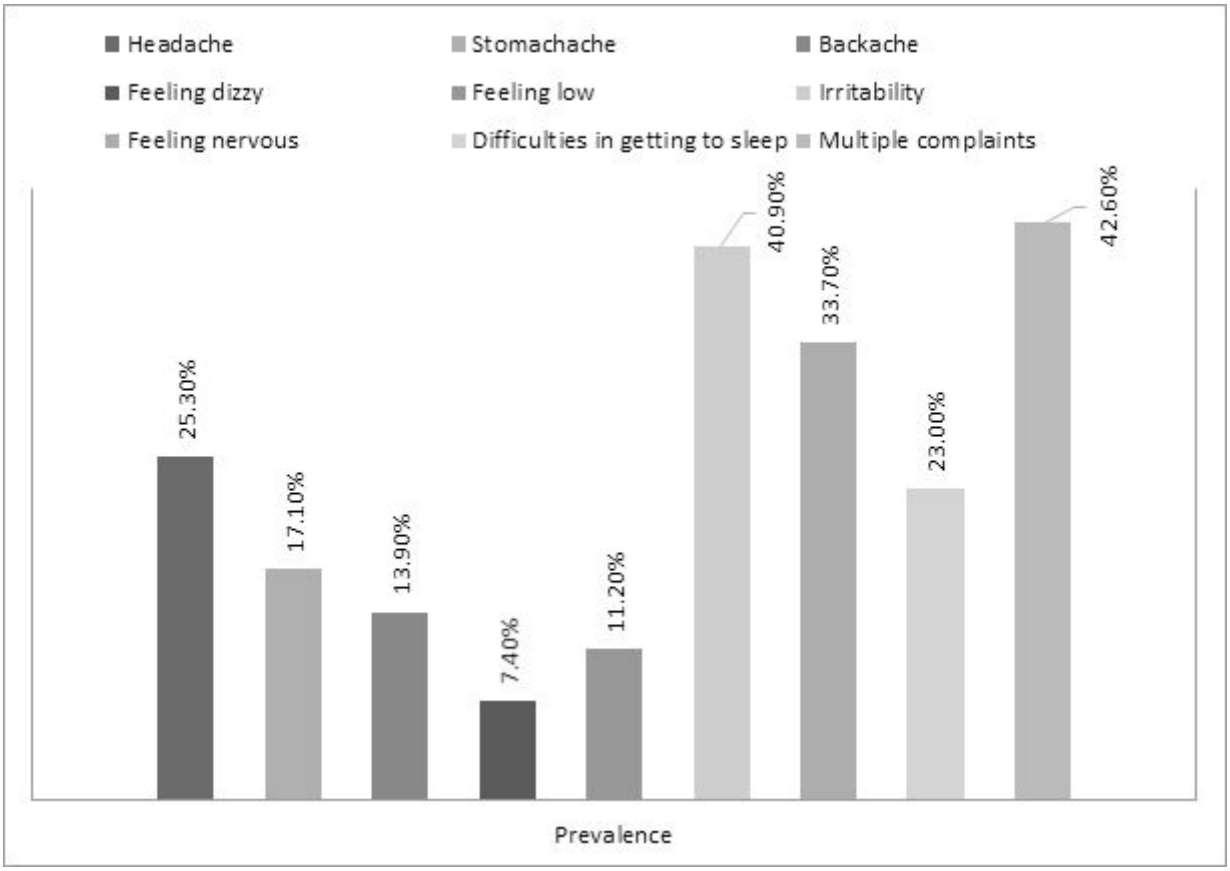

Figure 1

The prevalence of each subjective health compliant in the study populations