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Original article

Patterns of Health-Related Gender Inequalities—A Cluster Analysis of 45 Countries

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A B S T R A C T

Purpose: The paper explores gender inequalities between 45 countries across 10 health indicators among adolescents and whether those differences in health correlate with gender inequality in general.
Methods: Data from 71,942 students aged 15 years from 45 countries who participated in the 2018 Health Behaviour in School-aged Children survey were analyzed. For this purpose, 10 indicators were selected, representing a broad spectrum of health outcomes. The gender differences in the countries were first presented using odds ratios. Countries with similar risk profiles were grouped together using cluster analyses. For each of the 10 indicators, the correlation with the Gender Inequality Index was examined.
Results: The cluster analysis reveals systematic gender inequalities, as the countries can be divided into seven distinct groups with similar gender inequality patterns. For eight of the 10 health indicators, there is a negative correlation with the Gender Inequality Index: the greater the gender equality in a country, the higher the odds that girls feel fat, have low support from families, have low life satisfaction, have multiple health complaints, smoke, drink alcohol, feel school pressure, and are overweight compared with boys. Four indicators show a divergence: the higher the gender equality in a country in general, the larger the differences between boys and girls regarding life satisfaction, school pressure, multiple health complaints, and feeling fat.
Conclusions: Countries that are geographically and historically linked are similar in terms of the health risks for boys and girls. The results challenge the assumption that greater gender equality is always associated with greater health equality.

IMPLICATIONS AND CONTRIBUTION

This article provides an overview of health inequalities in 45 countries. Health inequalities between boys and girls persist, and varying patterns per country are observed. Based on the results, policymakers can address these inequalities in an evidence-based manner.

Men and women differ greatly in terms of health, for example, with regards to the prevalence of disease, life expectancy, and causes of death. Many studies suggest that these differences are more attributable to gender than to sex [1–3]. As such, sex, which manifests itself in the form of chromosomes, genitalia, and hormones, is less important than the social roles ascribed to men

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and women by society. Gender differences in social roles are expressed, among other things, in education and occupation, power, attitudes, and behavior. Viewed globally, women are less active in the labor market than men. Instead, women are responsible for (mostly unpaid) household work and caregiving [4]. As a consequence, men have more resources available to them than women, for example, in the form of income, power, and prestige. Closely related to this are socially shaped expectations about appropriate behavior for men and women [3]. Adhering to stereotypical masculine concepts, such as independence, stoicism, and strength, is positively associated with risk behaviors, such as substance use, and negatively associated with health-promoting behaviors [5]. Women are typically expected to take care of their bodies to be attractive to men, but at the same time, they are not allowed to live out their sexuality as freely as men. Therefore, a typical health risk for women is, for example, a higher level of dissatisfaction with their own body. However, stricter social norms for women can also protect against the aforementioned typical male health risks [6].

Because countries differ in terms of which social norms apply to men and women respectively, international comparative research on gender differences in health is needed. This kind of research usually focuses on individual outcomes, such as smoking [7], alcohol use [8], or obesity [9,10] rather than on a wide range of outcomes. These studies often do not focus on adolescents, although adolescence is a formative phase for healthy and harmful behavior in adulthood [11,12]. In addition, there are few international comparative studies that examine the extent to which gender differences in health are related to gender inequality in a country as a whole. On the basis of these considerations, there are two gaps in research that this article aims to fill. First, to explore whether there are groups of countries that have similar profiles of health-related gender inequalities that are distinct from other groups of countries. For this purpose, a cluster analysis is carried out. Second, this article investigates if gender differences regarding these indicators correlate with general gender inequality in the respective countries.

Gender inequality and health

Two studies have shown a correlation between the Gender Inequality Index (GII) and the prevalence of obesity in adults. In countries with a high degree of gender equality, obesity rates of men and women are similar, but the greater the gender inequality, the higher the excess female obesity [13,14]. For the European Union, it has been shown that in countries with higher gender equality, the differences in life expectancy between men and women are smaller [15]. A similar study found this result on a smaller scale level when comparing the 16 German states. The German data showed that the higher the gender equality according to the GII, the higher the life expectancy of men, whereas this correlation was not apparent for women [16]. A study on the mental health of the entire population in 122 countries showed that the higher the gender inequality, the more often women have depressive disorders compared with men, suggesting that women are mentally more affected by gender inequality than men [17].

There are few cross-national studies that focus on the link between gender inequality and adolescent health. A study from 2006 showed that in countries with higher general gender equality, boys and girls are also similar in terms of psychosomatic complaints. Conversely, the higher the inequality, the more complaints girls had compared with boys [18]. A study in 24 European Union countries found that the higher the gender inequality, the less likely adolescent girls are to engage in problem behaviors (i.e., a composite measure comprising drunkenness, playing truant, trouble with teachers, trouble with police, etc.) compared with boys [19]. A recent study has shown that the higher the gender equality in a country, the higher the life satisfaction of both boys and girls [20]. A further study has shown that the higher the gender inequality in a country, the higher the differences between boys and girls in physical activity, fighting, and injuries [21].

The indicators of health

For the analyses, 10 indicators were selected that are particularly relevant to adolescents' health, and of which, it is known that there are marked gender differences between countries [22]. Data from 45 countries in Europe, Asia, and North America that participated in the recent Health Behaviour in School-aged Children (HBSC) 2018 study are compared. The understanding of health that underlies the HBSC study is based on the broad and holistic understanding of health that goes back to the WHO Ottawa Charter [23]. Health encompasses physical, social, and emotional well-being, with both positive aspects and risk factors playing a role. The research perspective of HBSC is, therefore, primarily a social science perspective and less a biomedical one [24].

Overweight and obesity are severe global pandemics according to the Global Burden of Disease Study, as more than 100 million children and more than 600 million adults were obese in 2015. High body mass index (BMI) accounted for four million deaths in 2015, most of them due to cardiovascular disease and type 2 diabetes [9]. Obesity in childhood is a severe health problem, as the risk of having obesity in an adult increases five times [25]. In the vast majority of countries participating in the HBSC study, it has been shown that boys are significantly more likely to be overweight and obese than girls [10].

In contrast to the actual weight, *body image* is the individual perception and evaluation of one's body [26]. Having a positive body image is associated with better well-being and nutritional behavior [27]. In general, a higher BMI decreases the probability of having a positive body image [27], and girls are more likely to perceive themselves as fat than boys [28].

A systematic review has shown that *physical activity* in adolescence is positively associated with better mental health (i.e., less anxiety, depression syndromes, and a better self-concept) and academic performance, higher bone strength and aerobic fitness, and more strength and endurance [29]. Between 2002 and 2014, the overall proportion of young people who were physically active was stable across the years in the HBSC countries, with boys being more active than girls [10].

Adolescence is a phase of transition from childhood to adulthood, characterized by an increased willingness to take risks. Adolescents often drink *alcohol* and *smoke* for the first time during this period. Alcohol consumption is associated with multiple health risks, such as injuries, cardiovascular disease, and cancer [8]. A specific problem for adolescents is that alcohol use and school disengagement may emphasize each other, which may ultimately lead to school dropout [30]. Smoking can cause or aggravate diseases and is, as such, responsible for the second-highest disability-adjusted life years worldwide after high blood pressure [2]. In most countries, consumption of both

alcohol and tobacco has been decreasing in the last decades [7,31], and although gender differences have narrowed over time among adolescents, boys are still more likely to smoke and drink than girls [31,32].

For adolescents, school is an important educational setting where they spend a lot of time. Feelings of not meeting expectations can be perceived as psychological stress. Higher *schoolwork pressure* is associated with psychosomatic symptoms [33] and lower academic performance [34]. Overall, trends in perceived school pressure were stable between 1994 and 2010. However, there were clear differences between countries, and girls generally indicated more school pressure than boys [35].

A recent UNESCO report defined *bullying* as "aggressive behavior that involves unwanted, negative actions that are repeated over time, involving an imbalance of power or strength between the perpetrator or perpetrators and the victim" [36]. In the short term, bullying can result in poorer grades [37]; in the long term, two cohort studies showed that adults who were bullied as children suffered more frequently from poor health, were at increased risk for having problematic social relationships, had a lower income [38] and a lower quality of life [39] than adults who were not bullied as children.

Family support has been shown to be crucial for adolescent health, as young people who feel supported by their family have better mental health, smoke less, and drink less alcohol [40]. Furthermore, the correlation between schoolwork pressure and health problems can be mitigated through supportive communication with parents [41]. In the 2014 HBSC survey, gender differences among countries were mixed. In some countries, girls reported more family support, in others, boys, but in the majority of countries the differences were not statistically significant [22].

The term *subjective health complaints* covers a variety of symptoms, ranging from occasional ailments to illnesses that significantly affect life. The HBSC study surveys the prevalence of eight common symptoms in adolescents (e.g., headache and feeling dizzy). A validation study has shown that these complaints can be regarded as a measure of psychosomatic health [42]. A cohort study from Finland has shown that psychosomatic symptoms in adolescents can be early warning signals of anxiety disorders and depression in adulthood [43]. Accordingly, it has also been shown that the number of subjective health complaints is highly correlated with suicidal ideation and behavior [44]. In 2014, the HBSC countries differed widely in the prevalence of subjective health complaints in adolescents. However, in almost all countries, girls were significantly more likely to suffer from multiple health complaints than boys [22].

Life satisfaction is a cognitive measure of a person's well-being. It is a general appraisal that can include academic and economic success, social relationships, and health. Life satisfaction is associated with many emotional, social, and behavioral outcomes in adolescence. It is positively correlated with, for example, positive mental health [45], self-rated health [46], and less substance use [47]. Studies have shown that life satisfaction is higher in countries with higher gender equality [20], and that boys are more likely to report higher levels of life satisfaction than girls [22].

The 10 indicators have been selected because they comprise the large majority of the overarching topics covered in the HBSC questionnaire. Only the topic of sexual health could not be included, as two countries did not ask questions on sexual health. If several indicators were available for one topic, the indicator with the higher relevance to health was selected. For example, both the 30-day prevalence and lifetime prevalence of alcohol and tobacco use were surveyed. The 30-day prevalence was selected because it reflects current behavior and is as such of higher importance for health than the lifetime prevalence. The indicators were also selected in such a way that they do not correlate with each other to a very high degree. This ensures that the indicators cover a broad spectrum of health and avoids that one aspect of health dominates the result of the cluster analysis.

Regarding the cluster analysis, we expected that neighboring countries would be grouped together. The reason for this assumption is that neighboring countries usually have shared cultural characteristics, that is, they are often similar in terms of languages, religion, values, and norms. This consideration is supported, for example, by the Inglehart-Welzel Cultural Map, which classifies countries into groups according to their shared dominant values. These groups usually consist of neighboring countries and countries that are historically closely connected, for example, through a shared religion [48]. In addition, the numerous classifications of countries in welfare regimes usually group neighboring countries together [49,50]. Therefore, neighboring countries can also be expected to have similar profiles in the differences in health indicators between girls and boys.

With regard to the correlation between the GII and the 10 health indicators, we expected that higher overall gender equality would also be reflected in higher health equality because this is what the majority of the aforementioned studies have shown. However, some of the studies are older [18], cover a different spectrum of countries, age groups, and outcomes [15,16,19], making comparisons difficult.

Methods

In the following sections, we will explain the main features of the HBSC study and how the selected health indicators were measured. Next, we explain how gender differences are presented using odds ratios and scatterplots and how the differences are aggregated into country groups using cluster analysis.

About HBSC

The HBSC study is a World Health Organization collaborative cross-sectional study currently conducted in 47 countries across Europe, Asia, and North America. Data collection procedures in all countries were conducted in accordance with a standardized international protocol. Institutional ethical consent was obtained in each participating country. Data are collected in school settings every 4 years from a nationally representative random cluster sample of adolescents aged 11, 13, and 15 years in each participating country. The primary sampling units are classes. More detailed information about the methodology of the HBSC study is reported elsewhere [24]. The following analyses are limited to adolescents aged 15 years because previous HBSC studies have shown that gender differences are bigger in this age group than in the younger groups. Accordingly, it is to be expected that possible patterns are more apparent in this group [22].

Measurement

The indicators described below were developed by HBSC or other studies and have been used and validated in previous HBSC studies [22,24].

1. *Overweight*: The BMI was calculated from the information given by the students on their height and weight, and the thresholds of the International Obesity Task Force were used to identify overweight students [51].
2. *Low life satisfaction*: Life satisfaction was measured using a Cantril ladder [52], ranging from 0 (low) to 10 (high). The cut-off was the mean life satisfaction in the respective country, meaning that any student with life satisfaction below the country mean has a low level of life satisfaction.
3. *Multiple health complaints*: Students were asked how often eight different health complaints had occurred during the past 6 months (headache, abdominal pain, backache, feeling low, irritability or bad mood, feeling nervous, sleeping difficulties, and dizziness). Answers ranged from 1 "about every day" to 5 "rarely or never." Multiple health complaints were defined as indicating two or more complaints occurring more than once a week.
4. *Body image "fat"*: Students were asked to assess their body size on a 5-point scale ranging from 1 "much too thin" to 5 "much too fat." The body image defined as "fat" included answers 4 ("a bit too fat") and 5.
5. *Low level of physical activity*: Students were asked how often they exercise during a week with answers ranging from 1 "every day" to 7 "never." A low level of physical activity was defined as three times or less (codes 3–7).
6. *Current use of alcohol*: Students were asked on how many days they had drunk alcohol during the last 30 days. Answers ranged from 1 "never" to 7 "30 days (or more)." Current use of alcohol was defined as stating having drunk alcohol on at least "1 or 2 days" in the last 30 days.
7. *Current smoking*: Students were asked on how many days they had smoked during the last 30 days. Answers ranged from 1 "never" to 7 "30 days (or more)." Anyone stating having smoked on at least "1 or 2 days" in the last 30 days was defined as current smoker.
8. *School pressure:* Students were asked how much pressure by schoolwork they felt. Answers ranged from 1 "not at all" to 4 "a lot." Answers 3 and 4 were defined as experiencing school pressure.
9. *Bullying victimization:* Students were asked how often they had been bullied in the past couple of months using a scale ranging from 1 "have not been bullied" to 5 "several times a week." Anyone who stated having been bullied at least "2 or 3 times per month" (i.e., codes 2–5) was defined as bullying victim.
10. *Low level of family support:* Four items regarding family support were asked using a 7-point scale, with 1 indicating a low level of support and 7 indicating a high level. A mean lower than 5.5 was defined as the threshold for a low level of family support.

The GII is a composite measure that combines the following indicators: maternal mortality ratio, adolescent birth rate, women's share of seats in parliament, male and female population with at least some secondary education, and male and female labor force participation. Lower GII values indicate more gender equality. The GII was presented for the first time in 2010, the recent version is based on 2017 data [53].

Statistical analyses: prevalence and odds ratios, correlations, and cluster analysis

First, the correlations between the nondichotomized health indicators were calculated. In the case of health complaints, the number of complaints occurring more than once a week was counted. Subsequently, the 10 health indicators were dichotomized as described, and the respective prevalence were calculated for boys and girls. The corresponding prevalence will be published in the International Report HBSC 2018, only the odds ratios are presented in this article. Chi-square statistics were used to calculate whether the gender differences were statistically significant. It was taken into account that the data were obtained by a clustered sampling.

For each of the 10 health indicators, the correlation between the odds ratios and the GII was calculated. The correlations are visualized using scatterplots, and the variance explained is quantified using R^2.

To find out whether there is a pattern regarding the odds ratios for the 10 health indicators of the 45 countries, the data were further condensed with the help of a cluster analysis. In the first step, a hierarchical cluster analysis was carried out. Complete linkage was used as the cluster method because it leads to compact and homogeneous clusters and does neither tend to build chains [54] nor to form clusters of the same size [55], which could not be assumed a priori. The distance was measured as squared Euclidean distance, and the number of clusters was determined using the elbow criterion. The number of clusters and the mean values of these clusters as a result of hierarchical cluster analysis were used as a starting point for the next step, the centroid-based clustering (k-means). In this second and final step, the assignment of countries to clusters was validated and slightly improved. All analyses were conducted using SPSS Statistics 25, IBM Corp., Armonk, NY.

Results

Description of the sample

The following analyses include the data of 71,942 students aged 15 years from the 45 countries whose data were available at the time of the analysis. The smallest sample was drawn in Greenland and the largest in Wales (sample sizes by country can be found online in the additional material). The gender ratio was almost balanced, with 51.2% of girls (Table 1).

Correlation between health indicators

The correlation matrix shows correlations $<.1$ for 28 of the 45 combinations (Table 2). Small correlations ($.1 < r < .3$) can be found between life satisfaction and the number of health complaints on the one hand, and the other indicators on the other hand, with the exception of the BMI, which shows even weaker correlations. Only the following three correlations are greater than .3. Students with a higher BMI also rate themselves more often as too fat, tobacco consumption is positively correlated with alcohol consumption, and a higher number of health complaints is associated with lower life satisfaction. The correlation matrix shows that the indicators as a whole represent a broad spectrum of health and are suitable for cluster analysis.

Description of health indicators by country and gender

Table 3 shows the girls/boys odds ratios of the 10 dichotomized health indicators by country with the countries sorted by ascending GII. The recent version of the GII ranks 160 countries on gender inequality by attributing each country with a value

Table 1
Description of the sample

Number of countries	45	
Total sample size	71,942	100.0%
Boys	35,089	48.8%
girls	36,853	51.2%
Average sample size per country	1,599	
Smallest sample	314 (Greenland)	
Biggest sample	4,304 (Wales)	
Age	15 year olds only	

ranging from 0 to 1. The higher this value, the higher the gender inequality is present in the respective country. Switzerland is the country with the lowest GII value (rank 1, GII .039) and Georgia with the highest value (rank 78, GII .350) in our sample. All the HBSC countries are below the worldwide mean of .441.

With regard to body image, in almost all countries, girls have higher odds of perceiving their bodies as "fat" than boys, whereas their odds of actually being overweight are lower. For both variables, the trend is that in Nordic and Central European countries, odds ratios are above the HBSC average, whereas they are below the average in Eastern Europe, the Balkans, and Caucasus countries. With regard to GII, there is a tendency for both odds ratios to be lower in countries where gender equality is lower and vice versa.

Boys have higher odds of reporting more physical activity than girls in all countries. This difference was significant in all countries, with the exception of Finland and Norway. The difference is especially large in a number of Balkan, Central and Southern European countries such as Armenia and France, whereas the difference is smaller in most Nordic countries, such as Iceland.

In most countries, the odds ratios regarding smoking and alcohol use were nonsignificant. Statistically significant differences were found mainly in Eastern European and Asian countries. In these countries, the GII is higher in most cases, but the odds ratios are lower than the average of the HBSC countries, meaning that the odds of girls to report smoking and drinking are lower than the odds of the boys.

In all countries, girls have higher odds to report feeling pressured by schoolwork than the boys, and in 35 of the countries, the odds ratios are statistically significant. Particular high differences are found in some Scandinavian, Central European, and Mediterranean countries such as Sweden, Belgium (Flemish), and Italy. In countries with a high GII, however, the odds ratios of feeling pressured by schoolwork are smaller and often below the HBSC average.

There are only a few countries where the odds ratios of bullying are statistically significant. In Switzerland, girls have significantly higher odds of reporting being bullied than boys. In other countries, such as Georgia, girls have lower odds.

In most countries, girls have higher odds of indicating low family support than boys. Statistically significant gender differences to the advantage of girls with an odds ratio <1 are found only in countries with a high GII.

Multiple health complaints are the only indicators where the odds ratios are statistically significant in each country and in the same direction, with girls having higher odds of reporting multiple health complaints than the boys. Countries with exceptionally high odds ratios are widely dispersed, and there is no particular geographical pattern.

Odds ratios of having a low life satisfaction that are higher than the HBSC average are mostly found in countries with a low GII. Accordingly, odds ratios close to or even below 1 are more common in countries with high gender inequality.

Country clusters: composition and characteristics

The odds ratios were further condensed with the help of cluster analyses to see whether there are countries in which girls have similar risk profiles. Using hierarchical cluster analysis, seven country groups were identified, and the final allocation of countries to clusters was performed by k-means clustering (Table 4).

Cluster 1 comprises countries where girls have particularly low odds of being overweight, smoking, and drinking alcohol compared with boys in these countries. Similarly, their odds of feeling too fat or having multiple health complaints and low life satisfaction are comparatively low. However, their odds of exercising little is much higher than that of boys in the respective countries. The countries in this cluster are in part neighboring Balkan, Caucasus, and Central Asian countries.

Three features characterize *Cluster 2*. First, it is the largest cluster encompassing 12 countries. Second, the odds ratios for almost all health indicators are close to the HBSC cluster average. Third, girls have a higher odds ratio than the HBSC cluster average to exercise little and become victims of bullying compared with boys. Most countries in this cluster are located in Central Europe.

Bulgaria forms a cluster on its own (*Cluster 3*). Compared with the HBSC cluster average, the girls there have lower odds of feeling too fat (and also being fat), being physically active, feeling school pressure, indicating lower support from the family, having

Table 2
Correlation matrix (Pearson r)

	1	2	3	4	5	6	7	8	9	10
1. Body image	1									
2. BMI	.487**	1								
3. Physical activity	.044**	−.001	1							
4. Current smoking	.015**	.046**	.048**	1						
5. Alcohol use	.029**	.055**	−.021**	.392**	1					
6. School pressure	.088**	.033**	.050**	.017**	.046**	1				
7. Been bullied	.058**	.037**	.024**	.067**	.065**	.088**	1			
8. Family support	−.071**	−.031**	−.067**	−.098**	−.097**	−.084**	−.133**	1		
9. Health complaints	.135**	.038**	.106**	.160**	.135**	.262**	.188**	−.226**	1	
10. Life satisfaction	−.136**	−.056**	−.136**	−.113**	−.071**	−.193**	−.168**	.292**	−.383**	1

BMI = body mass index.
**$p < .001$.

Table 3
Overview of health-related gender inequalities—countries sorted by ascending Gender Inequality Index (GII)

	Girls/boys odds ratios										
Country (ISO-Code)	Body image "fat"	Overweight	Low physical activity	Current smoking	Alcohol use	School pressure	Been bullied	Low family support	Multiple health complaints	Low life satisfaction	GII
Switzerland (CHE)	**2.44**	**0.51**	**2.34**	0.85	0.85	**1.38**	**1.59**	**1.28**	**3.11**	**1.90**	0.039
Denmark (DNK)	**2.65**	**0.62**	**1.61**	0.87	1.28	**1.55**	0.82	**1.66**	**2.46**	**1.77**	0.040
Greenland (GRL)	**3.87**	1.02	**1.77**		1.03	1.09	1.31	1.27	**2.78**	**2.06**	0.040
Sweden (SWE)	**3.03**	0.78	**1.93**	1.19	1.33	**2.90**	0.86	**1.37**	**3.16**	**1.72**	0.044
Netherlands (NLD)	**3.20**	**0.64**	**2.03**	0.94	1.02	**2.24**	0.91	**1.61**	**2.35**	**2.02**	0.044
Belgium (Flemish) (BE-VLG)	**3.14**	1.18	**1.89**	0.70	1.19	1.26	1.19	**1.74**	**2.20**	**1.48**	0.048
Belgium (French) (BE-WAL)	**1.66**	**0.65**	**2.33**	1.02	0.76	**2.94**	1.54	1.25	**2.56**	1.29	0.048
Norway (NOR)	**2.74**	**0.53**	1.22	0.65	0.71	**2.33**	0.63	1.04	**2.31**	**1.50**	0.048
Slovenia (SVN)	**2.15**	**0.58**	**3.01**	1.23	0.85	**3.31**	0.88	1.19	**3.71**	**2.18**	0.054
Finland (FIN)	**2.50**	**0.68**	1.35	0.95	0.99	**2.54**	0.78	**1.50**	**2.76**	**2.28**	0.058
Iceland (ISL)	**1.99**	0.74	**1.22**	0.78	1.09	**2.62**	**0.13**	1.01	**2.37**	**1.83**	0.062
Luxembourg (LUX)	**1.91**	0.83	**3.11**	1.23	0.86	**1.62**	0.92	1.24	**2.12**	**1.33**	0.066
Austria (AUT)	**1.88**	**0.63**	**2.34**	1.16	1.11	1.36	1.07	**1.36**	**2.91**	**2.32**	0.071
Germany (DEU)	**2.12**	0.78	**2.06**	1.03	1.04	1.18	1.11	1.00	**2.53**	**1.56**	0.072
Spain (ESP)	**2.24**	**0.60**	**2.60**	1.17	1.10	**1.55**	1.60	1.07	**2.92**	**1.89**	0.080
France (FRA)	**2.20**	**0.69**	**3.52**	1.22	0.89	**1.91**	1.26	**1.37**	**2.25**	**1.49**	0.083
Italy (ITA)	**1.75**	**0.44**	**2.50**	**1.57**	**0.75**	**2.62**	0.60	1.30	**3.76**	**1.49**	0.087
Portugal (PRT)	**1.88**	0.93	**3.11**	0.77	1.03	**2.75**	1.12	1.14	**3.60**	**1.45**	0.088
Canada (CAN)	**1.73**	**0.67**	**1.63**	1.27	**1.35**	**2.25**	1.03	**1.25**	**3.30**	**2.11**	0.092
Ireland (IRL)	**3.35**	1.09	**2.15**	1.03	1.14	**1.70**	0.71	1.12	**2.26**	**1.34**	0.109
England (GB-ENG)	**2.58**	0.81	**2.27**	1.19	0.90	**1.72**	0.70	**1.47**	**2.30**	1.31	0.116
Scotland (GB-SCT)	**2.34**	**0.42**	**1.65**	0.96	1.37	**2.54**	0.83	0.95	**2.09**	**1.45**	0.116
Wales (GB-CYM)	**2.05**	**0.69**	**2.67**	**1.58**	**1.21**	**2.49**	1.05	**1.27**	**2.56**	**1.69**	0.116
Greece (GRC)	**1.57**	**0.37**	**2.05**	1.22	0.86	**1.69**	1.04	**1.59**	**2.77**	**1.99**	0.120
Estonia (EST)	**1.89**	**0.61**	**1.61**	0.84	0.96	**1.73**	0.70	1.20	**2.61**	**1.58**	0.122
Lithuania (LTU)	**3.02**	**0.58**	**2.37**	0.86	1.15	**2.04**	0.77	1.17	**2.68**	**1.58**	0.123
Croatia (HRV)	**1.71**	**0.50**	**2.76**	0.94	0.80	**1.91**	0.93	**1.42**	**2.85**	**1.54**	0.124
Czech Republic (CZE)	**1.61**	**0.51**	**2.19**	**1.43**	1.05	**1.53**	1.10	**1.23**	**2.49**	**1.69**	0.124
Poland (POL)	**2.32**	**0.29**	**1.87**	1.24	1.05	**2.50**	0.64	1.14	**2.06**	**1.76**	0.132
North Macedonia (MKD)	1.12	**0.44**	**2.82**	**0.60**	**0.61**	**1.59**	1.07	1.32	**2.67**	**1.42**	0.149
Slovakia (SVK)	**1.61**	**0.54**	**2.37**	1.12	0.85	1.35	0.82	1.11	**1.99**	**1.94**	0.180
Serbia (SRB)	1.30	**0.48**	**3.85**	1.30	0.82	1.06	0.92	0.99	**2.47**	**1.65**	0.181
Latvia (LVA)	**2.39**	**0.68**	**1.84**	1.21	**1.58**	**1.80**	0.85	**1.47**	**3.31**	**1.61**	0.196
Kazakhstan (KAZ)	**2.37**	0.73	**2.22**	**0.50**	0.67	1.06	1.02	0.74	**1.99**	1.06	0.197
Malta (MLT)	1.12	0.65	**2.50**	**0.51**	0.76	**2.56**	**0.55**	**0.58**	**2.23**	**1.54**	0.216
Bulgaria (BGR)	1.05	**0.50**	**1.52**	**1.73**	1.04	**1.26**	0.95	**0.55**	**1.63**	1.03	0.217
Moldova (MDA)	**1.95**	**0.44**	**2.38**	**0.29**	**0.51**	**1.69**	1.15	0.86	**2.70**	1.02	0.226
Albania (ALB)	1.35	**0.33**	**3.05**	**0.32**	**0.43**	**1.59**	1.67	1.18	**2.98**	1.12	0.238
Russia (RUS)	**1.71**	**0.57**	**1.70**	**0.66**	0.81	**1.35**	0.88	1.02	**1.98**	1.18	0.257
Hungary (HUN)	**1.98**	**0.65**	**1.79**	1.31	1.01	**1.47**	0.87	**1.48**	**2.42**	**1.52**	0.259
Armenia (ARM)	1.10	**0.38**	**3.53**	**0.07**	**0.38**	**1.52**	1.03	**0.70**	**1.83**	1.03	0.262
Ukraine (UKR)	**2.74**	**0.52**	**1.95**	**0.47**	1.20	1.16	0.91	0.88	**3.06**	**1.27**	0.285
Romania (ROU)	**1.92**	**0.57**	**2.72**	0.95	**0.48**	**1.69**	1.06	**1.52**	**2.83**	**1.35**	0.311
Azerbaijan (AZE)	0.97	**0.24**	**2.18**	**0.56**	**0.25**	1.26	1.14	0.97	**1.68**	0.79	0.318
Georgia (GEO)	**1.42**	**0.41**	**2.97**	**0.25**	**0.50**	1.29	**0.54**	0.83	**2.16**	0.90	0.350
HBSC average	**1.95**	**0.58**	**2.17**	0.99	**0.94**	**1.71**	0.95	**1.15**	**2.51**	**1.54**	

Bold odds ratios (ORs) indicate significant gender differences ($p < .05$); green cells indicate OR lower than HBSC average; blue cells indicate OR greater than HBSC average; [1]GII for Denmark, [2]GII for Belgium, [3]GII for UK. Source: Gender Inequality Index from [53].

multiple health complaints, and experiencing low life satisfaction than boys. However, their odds ratio regarding smoking is the highest.

In *Cluster 4*, the odds ratios for alcohol consumption and low life satisfaction are the highest compared with values for girls in other clusters. Furthermore, it is noticeable that the odds ratio for overweight corresponds exactly to the HBSC cluster average, but the odds ratio for feeling too fat is above average. These characteristics make Cluster 4 different from Clusters 2, 3, and 6. However, the odds ratio is comparatively low with regard to physical activity. This cluster mainly comprises Nordic and Baltic countries.

Cluster 5 groups together countries where the odds ratios of feeling too fat, actually being overweight, and indicating low family support are higher than the HBSC average. Regarding the other indicators, they are close to the average of other countries. The odds ratio for feeling too fat compared to boys is the highest compared with values for other girls in other clusters. In terms of some indicators, this cluster is the counterpart to Cluster 1. Where odds ratios are low in Cluster 1, they are high in Cluster 5

Table 4
The results of the k-mean clustering

Cluster	OR of feeling fat	OR of overweight	OR of low physical activity	OR of current smoking	OR of alcohol use	OR of school pressure	OR of been bullied	OR low family support	OR of multiple health complaints	OR of low life satisfaction
1: ALB, ARM, AZE, GEO, KAZ, MDA, MKD	1,47	0,42	2,74	0,37	0,48	1,43	1,09	0,94	2,29	1,05
2: AUT, CHE, CZE, DEU, ESP, FRA, GRC, HRV, LUX, ROU, SRB, SVK	1,88	0,58	2,66	1,14	0,89	1,52	1,12	1,26	2,60	1,72
3: BGR	1,05	0,50	1,52	1,72	1,05	1,25	0,95	0,55	1,64	1,02
4. CAN, DNK, FIN, GB-SCT, LTU, LVA, NLD,POL, SWE	2,58	0,60	1,81	1,05	1,24	2,26	0,83	1,35	2,68	1,81
5: BE-VLG, GB-ENG, IRL	3,02	1,03	2,10	0,97	1,07	1,56	0,86	1,45	2,25	1,37
6: EST, HUN, ISL, MLT, NOR, RUS, UKR	2,02	0,61	1,71	0,75	0,93	1,89	0,67	1,03	2,43	1,49
7: BE-WAL, GB-CYM, ITA, PRT, SVN	1,90	0,66	2,72	1,24	0,92	2,82	1,04	1,23	3,24	1,62
HBSC cluster average	2,04	0,60	2,29	0,95	0,92	1,86	0,95	1,18	2,57	1,54

Green = girls/boys OR below the HBSC cluster average; blue = girls/boys OR above the HBSC cluster average.
Country codes (ISO 3166): ALB: Albania, ARM: Armenia, AUT: Austria, AZE: Azerbaijan, BE-VLG: Belgium (Flemish), BE-WAL: Belgium (French), BGR: Bulgaria, CAN: Canada, CHE: Switzerland, CZE: Czech Republic, DEU: Germany, DNK: Denmark, ESP: Spain, EST: Estonia, FIN: Finland, FRA: France, GB-ENG: England, GB-SCT: Scotland, GB-CYM: Wales, GEO: Georgia, GRC: Greece, GRL: Greenland, HRV: Croatia, HUN: Hungary, ISL: Iceland, IRL: Ireland, ITA: Italy, KAZ: Kazakhstan, LVA: Latvia, LTU: Lithuania, LUX: Luxembourg, MDA: Moldova, MKD: North Macedonia, MLT: Malta, NLD: Netherlands, NOR: Norway, POL: Poland, PRT: Portugal, ROU: Romania, RUS: Russia, SRB: Serbia, SVK: Slovakia, SVN: Slovenia, SWE: Sweden, UKR: Ukraine.
HBSC = Health Behaviour in School-aged Children; OR = odds ratio.

and vice versa. Cluster 5 includes two English-speaking countries and the Flemish-speaking part of Belgium.

Cluster 6 includes countries where girls have significantly lower odds of bullying than boys. In terms of exercise and smoking, the odds ratio is below the HBSC cluster average. For the other indicators, the odds ratios are close to the average. Geographically, the cluster is widely dispersed, with a focus on countries in Northern and Eastern Europe.

Cluster 7 includes countries where girls have higher odds of reporting school pressure and multiple health problems than boys. It is also noticeable that their odds of smoking are higher. Other than that, the odds ratios are close to the HBSC cluster average. Geographically, it is striking that this cluster does not include neighboring countries; however, three Mediterranean countries are included in this cluster.

Correlations between the GII and the health indicators

For the 10 health indicators from Table 3, the correlations with the GII were calculated and visualized in the form of scatter plots (Figure 1). There was only one positive correlation: In countries with a high level of gender equality, the differences between boys and girls regarding physical activity are smaller. However, with r = .217, the strength of correlation is low (R^2 = .047). There was no meaningful correlation between GII and bullying (r = –.073; R^2 = .005). All other correlations were negative, and the associations are medium to large, ranging from r = –.323 (R^2 = .104) between multiple health complaints and GII and r = –.663 (R^2 = .440) between low life satisfaction and GII.

Discussion

In summary, the scatterplots show that the higher the gender equality in a country, the higher the odds of girls compared with boys that they feel fat, have low support from families, have low life satisfaction, have multiple health complaints, smoke, drink alcohol, feel school pressure, and are overweight. For four indicators, the expectation that higher overall gender equality is associated with higher health equality has been confirmed, as the regression lines for physical activity, alcohol use, smoking, and overweight point in the direction of an odds ratio of 1. However, the opposite is true for the indicators school pressure, multiple health complaints, feeling fat, and low life satisfaction, where the regression lines move away from an odds ratio of 1, indicating a divergence between boys and girls.

The observed convergences fit well with theoretical considerations and empirical observations. Smoking, drinking alcohol, and doing sports are activities with a male connotation. The more equal the genders are in a society, the more likely girls are to adopt the harmful behavior only acceptable for men [6]. It fits in with this interpretation that there was a convergence of alcohol consumption in the HBSC countries between 1997/1998 and 2005/2006. Both genders in a country and the countries as a whole have converged regarding drunkenness during this period [56]. If this convergence has continued, then the gender differences found in our article might reflect different stages of this development. The convergence in physical activity observed in this article was also evident in a study based on the 2010 HBSC data [21]. The convergence of overweight in this article corresponds to the convergence of obesity in adults [13,14]. In addition to the different age groups and the difference between overweight and obesity, it should also be noted that other studies include countries with significantly higher gender inequality.

It is more difficult to interpret the result that higher gender equality is associated with a divergence between boys and girls for school pressure, multiple health complaints, feeling fat, and low life satisfaction. For the indicator life satisfaction, Looze et al. [20] have shown with a multilevel analysis of the 2010 HBSC data that more gender equality is associated with an absolute higher level of life satisfaction in boys and girls. This was explained by

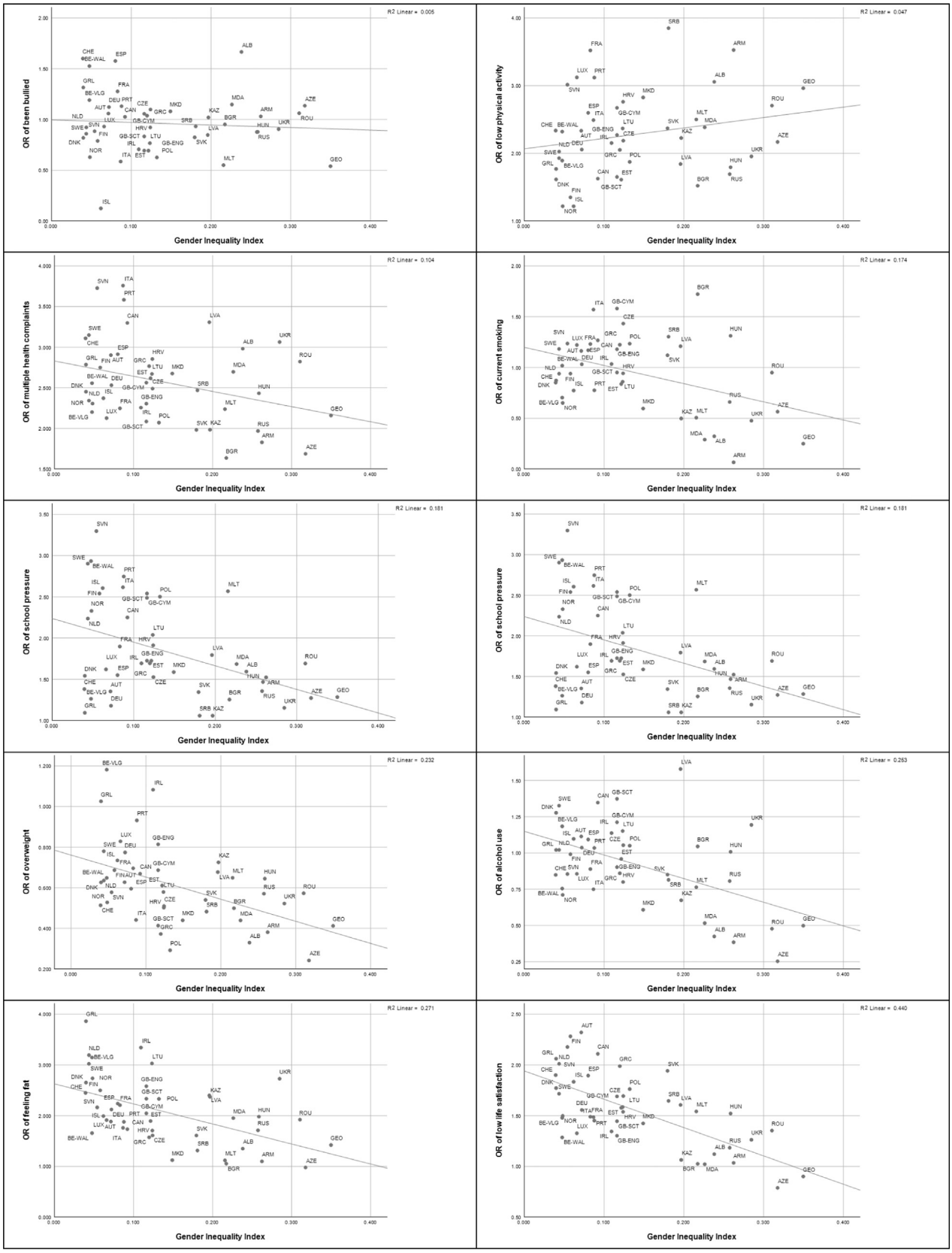

Figure 1. Scatterplots of the 10 health indicators and the Gender Inequality Index.

the fact that higher gender equality strengthens social bonds in a society, which helps both genders. Based on the current data, it should be examined whether boys benefit more from gender equality than girls. If this is the case, then a higher life satisfaction is also compatible with a divergence between boys and girls.

Based on HBSC data from 1997/1998, Torsheim et al. examined gender differences in subjective health complaints as a function of various macrolevel indicators. For adolescents aged 15 years, the difference between girls and boys was found to be smaller in countries with a higher Gender Development Index (GDI), but this correlation was not apparent for the Gender Empowerment Measure. A possible explanation was that the emergence of modern gender roles made it easier for boys to report health problems and made girls more prone to not report them [18]. It should be noted, however, that the studies are not directly comparable, partly because the GII and the GDI do not measure the same constructs. Moreover, the historical situations are hardly comparable. The countries with a lower GDI in the Torsheim study were states of the former Eastern Bloc. Accordingly, the participants were born in communist countries, which were affected by massive social upheavals at the time of the survey. The present study participants, on the other hand, were all born after the fall of the Iron Curtain and grew up with different gender norms. In this sense, the study from 1997/1998 could reflect a particular historical situation, which was also discussed as the reason for greater gender differences in depression in the adult population in Eastern Europe compared with Western Europe [57].

With regard to differences in the perception of schoolwork pressure, it should be noted that the GII compares men and women regarding their level of education and their labor force participation. Thus, it reflects the extent to which both genders are expected to succeed in education and work. Because education is the key to professional success, it seems plausible that school pressure will increase as expectations of girls' success at school rise. In this sense, improved opportunities for girls can also be seen as a cost of equality if higher expectations translate into higher perceived pressure. However, two things remain unclear. First, if a lower GII expresses that expectations of academic and professional success are similar for boys and girls, why do girls perceive much more school pressure than boys? One explanation can be provided by resource multiplication theory, which states that education is less beneficial for women than for men because they receive less authority, professional autonomy and pay for the same investment in education [58]. If this is the case, girls would have to work harder at school to meet the same expectations in the world of work that are placed on boys. Second, it remains unclear why the odds ratios for school pressure for countries with a low GII are so different. Switzerland and Sweden, for instance, have approximately the same GII, but in Sweden, the odds ratio for school pressure for girls at 2.90 is more than twice as high as in Switzerland (1.38). Pairwise in-depth comparisons between countries with such differences could help to understand the underlying mechanisms.

Similar considerations apply to the indicator of feeling fat. Because there is a strong correlation between the actual overweight and the assessment of being too fat, it is not surprising that the scatterplots for both variables show a negative correlation with the GII. It remains unclear why girls are much more likely to feel overweight than boys. Again, there are countries with a comparable GII that differ greatly in terms of odds ratios, for example, the French-speaking region of Belgium and the Netherlands. Both have a comparable GII, and the odds ratio for actual overweight is almost identical. However, in the Netherlands, the odds ratio for feeling fat is around twice as high compared with Belgium.

Apart from such outliers, our expectations regarding the cluster analysis have been largely confirmed. Many countries that rank close in the GII are geographically located in similar regions, and odds ratios of the health indicators tend to be similar. Accordingly, the cluster analysis has identified seven groups of countries with distinct gender profiles. The validity of the result of the cluster analysis is supported by the fact that the clusters are coherent in themselves. In clusters in which girls have a comparatively low risk of being overweight, they also have a lower risk of thinking they are too fat. In clusters where they smoke less than the boys, they also drink less. Where girls have a high risk of multiple health problems, their risk of low life satisfaction is also high. Finally, the clusters often include neighboring countries that are closely linked regarding their history and culture.

Strengths and limitations

One of the strengths of the present study is the large number of outcomes examined, which cover a wide range of health indicators. These variables were obtained in a highly standardized study using representative, generalizable samples. Similarly, the number of countries surveyed is large, but they only cover countries in the upper half of the GII. Thus, the results cannot be transferred to countries with higher gender inequality.

Limitations must be observed when interpreting the results. The results of this article are based on a cross-sectional analysis so that no evidence of causal relationships can be provided. As HBSC is a study that is repeated every 4 years; however, the postulated developments can be reviewed over time. A further limitation is that the cluster analysis and the scatter plots are an ecological analysis at the country level. The postulated explanations at this level have yet to be investigated using multilevel analyses and panel data.

A further limitation concerns the binary operationalization of gender. As in the previous survey cycles, the participants were asked whether they are boys or girls. In this question, it is unclear whether sex or gender is measured. Furthermore, this question is not appropriate for gender-nonconforming persons. In future HBSC studies, additional questions should ensure that a clear distinction is made between sex and gender, and that gender-nonconforming persons are included. However, survey research has not yet established best practice for asking about gender that works across countries.

Another limitation concerns the comparability of data across countries. Constructs such as health complaints may be understood differently in the participating countries. For some indicators such as subjective health complaints, cross-national comparability has already been tested, but only in a limited number of countries [18,59]. For factual questions (e.g., height and weight) and reports of behavior, there may be cultural differences regarding socially desirability response sets [60]. However, because all indicators have been dichotomized, at least slight exaggerations and understatements should not play a role.

Although the GII is widely used in public health research, it has been criticized for being unnecessarily complicated, for penalizing low-income countries, and for combining indicators specific to women with comparisons between men and women,

making its interpretation difficult [61]. Alternatives to the GII, such as the Gender Equality Index, Social Institutions and Gender Index, Global Gender Gap Index, and Women's Economic Opportunities Index, have other methodological disadvantages and advantages, but all these indices are highly correlated so that the ranks of the countries are also similar [62]. The abovementioned indices are also fundamentally criticized for their reliance on quantitative criteria, their narrow and neocolonial understanding of gender equality, and their failure to take intersectionality into account [63]. However, no alternative classification of the countries examined in this report is yet available that takes account of these objections.

Future directions

In this article, a large number of outcomes and countries were examined. It has been shown that there are groups of countries that are similar regarding gender differences in health. This article also shows that there are correlations between the GII and health outcomes to the detriment of girls, some of which cannot be explained well in theory. The exploratory approach with a large number of outcomes was necessary to obtain this overview. A logical next step would be to analyze individual outcomes using several independent variables to explain the findings more in detail. In the case of the HBSC study, multilevel analysis is particularly useful, as the data can be analyzed at the individual level, the level of school classes, schools, and countries. With such analyses, it can be established to what extent the results found are based on individual characteristics or characteristics at the mesolevel or macrolevel of the society. Aspects of intersectionality should also be taken into account, such as interactions between gender, wealth, and migration background. For this purpose, it is not necessary to compare several countries. For example, Bilal et al. [64] have studied how smoking among men and women in Spain developed between 1960 and 2010 and explained this in the context of the development of gender equality during this period. Analyses over time also help to understand the dynamics, that is, does convergence occur because the boys move toward the girls or vice versa or because both sexes move toward each other? Such in-depth analyses should also examine the role played by cultural values and religion [48,65,66] because the cluster analysis suggests that the gendered health profiles have profound socially determined causes. In addition, qualitative studies could be conducted to further explore how gender norms contribute to inequalities in adolescent health and the degree to which adolescents consciously challenge these norms.

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Supplementary Data

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