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Self-perceived psychosomatic health in Swedish children, adolescents, and young adults: An Internet-based survey over time

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Running title: Stress in youth examined on the Internet

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Summary

Article focus:

- Using the Internet to investigate self-perceived psycho-somatic health in the young in Sweden
- Does psychosomatic health improve in adolescents between 2007 and 2010

Key messages

- A high percentage of young subjects responded that they felt stressed very often/often; the numbers were higher for females than for males
- older teenaged females had more psychosomatic complaints compared to males
- both sexes had a slightly better self-perceived health status in 2007

Strengths and limitations

- Very large cohort of both children, adolescents and youn adults from the whole of Sweden
- All subjects responded completely voluntarily.
- There may be a selection bias, given that we do not know the psychosomatic health in subjects who are not logged onto the website.

Abstract

Objectives: We used the Internet to investigate self-perceived psychosomatic health in large groups of young people (10–24 years old) in Sweden, and to analyze trends during 2005 and 2010.

Design: cross-sectional

Setting: Internet survey across Sweden. Validated questionnaires were launched on the Internet by a recognized community site in a controlled manner.

Participants: When subjects logged in to their personal area, they could then answer questions regarding their health status with full freedom and anonymity.

Results: A high percentage of young subjects responded that they felt stressed very often/often; the numbers were higher for females than for males. The self-perceived health questionnaire revealed that older teenaged females had more psychosomatic complaints compared to males of similar ages; in contrast, in 10–12-year-old children, the percentage of psychosomatic complaints was similar for males and females. When we compared results obtained in 2010 to those obtained in 2007, we found that young people of both sexes had a slightly better self-perceived health status in 2007.

Conclusions: This novel Internet-based survey is a valuable tool for examining self-perceived health in young people over a broad range of ages. A relatively high percentage of young people, particularly females 16–18 years of age, had psychosomatic complaints that did not seem to improve from 2007 to 2010. A considerable worsening of these complaints occurred from the age of 12 years and onward in both sexes.

Key words: self-perceived health, psychosomatic, children, adolescents.

Introduction

The situation of children has changed dramatically over the past decades. Several conditions in today's modern information society have, in multiple ways, exposed children to seemingly increased levels of stress [1-2]. Lupien et al. pointed out that risk factors for the development of stress reactions depend primarily on the genetic vulnerability of the individual, the exposure to adverse life events, the socioeconomic situation, disturbances in important relationships, problems with school, and the timing of stressful events (3). Importantly, the development of stress reactions in young people is, to a great extent, gender dependent. Hence, it seems plausible that several factors, both psychological and physical, play important roles in children's well-being and ill health, with salient implications for future health and disease.

Given the recent development of higher frequencies of reported ill health in children, adolescents, and young adults, particularly in older teenage girls, both in Sweden and internationally (4-9), the purpose of this study was to obtain reliable information, both at a given time point and as a trend analysis, about perceived health in a wide range of ages of Swedish subjects 10–24 years of age. This was accomplished with a questionnaire comprising an eight-item scale of subjective health complaints and a general question about stress. The questionnaire was completed by a large number of subjects on the Internet site LunarStorm and its successor Wyeth. LunarStorm was one of the first web communities to be established in Sweden. Using a web-designed protocol, our primary aim was to explore psychosomatic health problems among children and adolescents in Sweden, focusing on sex and age differences. To our knowledge, this study is the first to use the Internet to examine self-perceived health in large cohorts of children, adolescents, and young adults on a completely voluntary

basis. Furthermore, we explored possible changes in the percentages of self-reported health complaints over a 3-year period from 2007 to 2010.

Methods

Data collection was performed with a self-administered Internet-based questionnaire consisting of three parts: (1) a single question about “stress,” launched on the Internet on a single day in January 2005. (2) Eight questions about self-perceived health that were completed in the period from 26 May to 28 June 2005, delivered on eight separate days with one question each day. (3) The same eight questions, delivered together to a smaller group of statistically randomly selected 15–20 year olds on the same day in May 2007, and then again to a new age-matched group of randomly selected adolescents and young adults in May 2010. The subjects had complete freedom regarding whether to fill out the questionnaire or to abstain.

Apart from the single question about stress, the aforementioned eight questions were developed and tested for reliability and used by the Swedish National Board of Health and Welfare (www.socialstyrelsen.se) in studies of the psychological health and well-being of children and adolescents. The composite measure of subjective health (7) comprises the following items: have difficulty concentrating, have difficulty sleeping, suffer from headaches, suffer from stomachaches, feeling tense, poor appetite, feeling low, and feeling dizzy. The response categories for all of these items, which are in the form of questions, are: don’t know; no, never; no, seldom; yes, sometimes; yes, often; and yes, always. The item about stress was described as “how often/seldom do you feel stressed?” and the response categories were: yes, very often; yes, often; yes, sometimes; no, seldom; no, very seldom, no, never; and don’t know.

Initially, we placed one question per day on LunarStorm's website (2005). The question was shown following log-in by the members of LunarStorm, and only one answer per log-in was allowed and counted. We focused on children, adolescents, and young adults ranging from 10 to 24 years old. The percentage of LunarStorm members of each age class in Sweden ranged from 20% to 88%, with the highest values (>80%) for adolescents between 13 and 16 years of age (Statistics Sweden, www.scb.se).

The number of 10–24-year-old responders to the single question about stress was 148,395 (85,330 girls). The first set of eight questions was placed on the website 4 months later. Given that these questions were placed one at a time, the response frequency varied between 12,000 and 45,000 subjects, who were mainly in the age groups 10–12 and 13–18 years, respectively, with similar response frequencies for all eight questions. The eight items were then released on the Internet on a single day in 2007 to a group of 15–20-year-old subjects who were randomly selected by the community websites using statistical methods; thus, children and younger adolescents were not included as they were in the protocol that consisted of one question on a single day. We chose to focus on 15–20 year olds because of their higher response rate. Given the very large number of responders to the questions that were launched on separate days, we were able to divide the subjects not only into gender groups, but also into various age groups (Table 1).

In another Internet-based protocol to determine trends of self-perceived health using the same eight questions described above, subjects were randomly selected in both

May 2007 and May 2010 to voluntarily respond to the questions. These groups comprised approximately 1,500 subjects aged 15–20 years (Table 2).

Ethical approval was obtained from the chairman of the review board. Putting questionnaires on the Internet does not require ethical approval from a committee according to the rules. However, we choose to discuss these issues thoroughly with the chairman and will full approval.

Statistical information and analysis

At the time of our investigations in 2005 and 2007, LunarStorm was the largest Internet community in Sweden. It had 1.3 million active members and approximately 360,000 unique visitors per day, who spent about 40 minutes on the site (TNS Gallup/Red Measure, Nielsen/Net Ratings). Of 15–20 year olds in Sweden, 83% were LunarStorm members, and 25 out of 30 pupils in every secondary school class were members (Lunarworks AB/SCB). The gender distribution of members was 53% females.

Due to the lack of normal distribution of the material and the categorical character of the questionnaire, nonparametric tests were used. These include Mann–Whitney U test and Kruskal–Wallis and chi-square tests. Each of the alternative responses to the questions was assigned a number, which was multiplied by the response frequency and then averaged. The answer “don’t know” was not included in the statistical calculations. Statistical significance was considered to be $p < 0.05$.

Results

Consistently more girls answered questions, and there was a general pattern in which the severity of the self-perceived health reported by the subjects declined as they get

older. The peak of problems experienced appeared to occur in adolescents aged 16–18 years, and, in addition, there were even more perceived problems in females.

Item about stress

The population who answered the single question about stress comprised approximately 148,000 individuals, of whom 57% were females. The vast majority of this population was between 10 and 24 years of age. When analyzing the total population, we found that 30% of the females and 19% of the males considered themselves to be stressed very often (Figure 1). Similarly, the response “yes, often” was provided more often by females: 17% vs. 10% in males ($p < 0.0001$). When the 10–24-year-old population was divided into age subgroups, we found that 16–18-year-old males and females reported the highest degree of stress (very often): 22% and 37% for males and females, respectively (Figure 2, $p < 0.0001$). The lowest number of subjects responding “yes, often” to stress was in the 10–12-year-old group. Consistently, females were statistically significantly more likely to report higher levels of stress (very often and often) than males from 10 to 24 years of age. The percentage of males responding “yes, very often” to the stress question remained relatively constant at 20% from 13 to 24 years of age, while the percentage of females responding “yes, very often” increased up until 16–18 years old and levelled off for those who were 19–24 years old. However, this older female group still showed statistically significantly higher values than males of the same age (Figure 2). Males of all ages chose the alternative response “no, never” to the question about stress statistically more frequently than females (Figure 2).

Eight questions presented on separate days to 10–24 year olds on the Internet (Table 1)

When all of the possible responses to all eight questions were considered, we found that males of all age groups scored higher in terms of self-perceived health compared to females ($p < 0.0001$). The only exceptions in which there were no differences between males and females occurred in the 10–12-year-old group regarding difficulty concentrating ($p = 0.11$), and in the 19–24-year-old group regarding difficulty sleeping ($p = 0.16$).

The influence of age, as judged from the four age groups and an analysis of responses to all of the questions (except for the question regarding poor appetite), revealed that the older the subjects, the poorer their self-perceived health ($p < 0.0001$). Both females and males demonstrated poorer self-perceived health the older they were ($p < 0.0001$ for both, except for $p = 0.04$ for poor appetite in females). However, males reported less headache ($p = 0.02$) and better appetite ($p = 0.003$) with increasing age. When we adjusted for the differences in sex, we found poorer self-perceived health with increasing age ($p < 0.0001$), with the exception of poor appetite ($p = 0.52$), for which males and females had opposite overall responses, as described above. Likewise, when we adjusted for differences in age, we found better self-perceived health in males compared to females ($p < 0.0001$).

Eight questions regarding self-perceived health presented together on the Internet in 2007 and 2010

Males reported better self-perceived health than females for all eight questions in the 2007 questionnaire (Figure 3, $p < 0.0001$). The results were similar in 2010, with males reporting better self-perceived health than females regarding headache, stomachache,

feeling tense, poor appetite, feeling low, and feeling dizzy (Figure 3, $p < 0.0001$), as well as difficulty sleeping ($p = 0.002$). However, the difference between males and female regarding difficulty concentrating was not statistically significant ($p = 0.06$). There were subtle differences between the overall responses to the 2007 and 2010 questionnaires. Males demonstrated better self-perceived health in 2007 vs. 2010 regarding feeling low, poor appetite, feeling tense, and difficulty sleeping and concentrating (Table 2). Females presented a similar pattern of better self-perceived health, with the exception of poor appetite (no change). The items stomachache, headache, and feeling dizzy remained unchanged from 2007 to 2010 for both sexes (Table 2).

Discussion

This study constituted a large web community–based survey of self-perceived psychosomatic health in young people 10–24 years of age, using well-established questions (6-8). We found marked differences between the sexes, with females reporting higher degrees of stress and psychosomatic symptoms compared to males. These symptoms appeared to be most pronounced between 16 and 18 years of age, and then to decline, supporting and extending the results of Hagquist (7). Similar findings using the same eight questionnaire items were reported previously (6,7); however, these were smaller regional studies that administered the questionnaires in person (the questionnaires have been handed out in schools). Major advantages of the present study are: (1) Subject can log into her or his own “LunarStorm corner” and choose voluntarily to fill out the questions on the Internet. They are thus more likely to be giving honest answers. (2) Many subjects of various ages responded to the questions.

When the single question regarding stress was placed on the LunarStorm website, females reported high degrees of stress (“very often” and “often”; Figures 1 and 2) more often than males, and they chose the response alternative “never” less frequently than males. The difference between female and male responses regarding high levels of stress was statistically significant. This pattern was supported by our eight follow-up questions, either asked collectively or one at a time; females reported more sadness, poor appetite, feeling tense, stomachache, headache, and difficulty sleeping and concentrating compared to males. As pointed out previously (7,8), females between 16 and 18 years of age are more likely than males of the same age to report feeling stressed. Our results further show that although fewer young people 19–24 years of age reported feeling stressed very often compared to 16 to–18 year olds, the number of females reporting that they felt stressed very often was still high (33% vs. 38%, respectively, for 19–24-year-old and 16–18-year-old females). The percentage of males reporting that they felt stressed very often was approximately 20%; this percentage was remarkably constant from 13 up to 24 years of age. In contrast, 13% of males and 15% of females who were 10–12 years old reported being stressed very often. Hence, in this age group, high levels of stress were reported less often and the discrepancy between the sexes was much lower than for older children and adolescents.

The present study also administered the same eight questions regarding psychological and psychosomatic health in 2007 and 2010. For several, but not all, of the questions that were asked, the self-perceived health was better in 2007 compared to 2010 for both males and females (Table 2 and Figure 3), perhaps reflecting the financial crisis

that emerged in 2008. Responses to the questions regarding stomachache, headache, and feeling dizzy did not change significantly between 2007 and 2010 for either sex.

Although the changes between 2007 and 2010 were quite small and the time elapsed perhaps too short, we did note similar degrees of differences between the responses of males and females in 2005, 2007, and 2010. Self-perceived health was undoubtedly worse for females compared to males, irrespective of age; this finding is supported by the results of Osika et al. (9), who used Beck Youth Inventory questionnaires.

Our data, together with the results of previous studies (4,7-9,10-11), point unequivocally to the presence of hampered psychological and psychosomatic health in the young, and the prevailing situation and trend does not seem to be improving. The psychosomatic health of young females is of particular concern, given the increase in complaints that appears to have taken place over the past 20 years, as indicated by surveys in Sweden (7). Although the figures are also high for males, they do not appear to have increased during the same elapsed period. However, the figures regarding alcohol problems, criminality, and suicide are much higher for males than for females in the 16–24-year-old age group (6).

Given that the majority of the examined subjects in the present study are of school age, the school environment is an important factor to consider with regard to the well-being of children and adolescents. Previous reports have established links between the environment at school and the psychological and psychosomatic symptoms of schoolchildren (5,12). Indeed, Hjern et al. (10) demonstrated an association between school stressors, such as harassment by peers, schoolwork pressure, and being

treated poorly by teachers, and psychosomatic pain and psychological problems, reflected as sadness, irritability, and feeling unsafe and nervous.

Methodological considerations and limitations

The eight-item scale that we used was validated in several studies as an appropriate means of estimating the subjective health complaints of children and adolescents. The instrument was also examined with the Rasch model, for which the property of invariance is essential (13,14). The Rasch model revealed that from a general level of analysis, the eight items were invariant among students with good health and among those with bad health. Importantly, these eight questions also work invariantly across time; i.e., there is no differential item functioning with respect to the year of investigation, which is a prerequisite for repeated analysis, as in the present study.

There are few data available regarding Internet-based surveys of psychological health among young people; hence, there are few validation analyses. However, a study by Mangunkusumu et al. (15) demonstrated good agreement between responses to questionnaires that were handed out manually and those administered via the Internet. Notably, the Internet approach received more favorable evaluations, even though it also took place in a school milieu. A major advantage of the present study was that the subjects could choose whether or not to answer the questions while in a familiar and comfortable environment. Furthermore, administrative factors such as data transcription, the risk of left-out values and “odd” answers, and the concern that other people might read the answers can be overcome by computer- and Internet-based surveys. Hence, Internet surveys assessing psychological health and well-being issues appear to be quite suitable for use in young people.

Compared to the response rates obtained from telephone or mail questionnaires, the number of responders per day may seem somewhat low. We received responses from between 100,000 and 150,000 individuals per day; this represents approximately 36% of the entire population of members (1.2 million). Roughly 350,000 people logged in on a given day, raising the possibility of selection bias. However, the response rate obtained at LunarStorm was very high for such a generalized Internet-based survey.

Conclusion

This novel Internet-based survey is a valuable tool for examining self-perceived health in young people over a broad range of ages. A relatively high percentage of young people, particularly females 16–18 years of age, had psychosomatic complaints that did not seem to improve from 2007 to 2010. A considerable worsening of these complaints occurred from the age of 12 years and onward in both sexes.

Thus, strong emphasis should be placed on improving life conditions during early phases, such as in school environments, and later on facilitating the transition into early adulthood.

Funding

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Data Sharing

There is no additional data available.

Contributorship

PF had the main responsibility for designing, analysing data and drafting the manuscript. CH and WO took active part in designing questions regarding psychosocial health, reviewing data analysis and made important commentaries on the text. Authors approve the present version to be published.

Competing interests

None.

Figure legends

Fig 1. Bars depict percentage number of responses (from alternatives never to very often) to the question “How often/seldom do you feel stressed?” for 10 to 24 year-old females and males. Total number of respondents was 148 395. For statistics, see text.

Fig 2. Bars demonstrate percentage number of responses, expressed as never and very often, to the question “How often/seldom do you feel stressed?” divided by sex and age. Numbers in graph represent number of responding individuals. Statistics in text.

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TABLE 1

Proportion responders in % of 8 questions assessing self-perceived health asked on the web in May 2005. The column "don´t know" is not included in the subsequent calculations

Question/alternative	Yes, always	Yes, often	Yes, some-times	No, seldom	No, never	don´t know	Number of responders	Sex, %
Difficulty in concentrating								
10-12 years old								
-females	7	8	40	17	11	17	7526	63,4
-males	12	7	34	17	16	15	4341	36,6
13-15 years old								
-females	14	17	45	11	5	8	28889	62,2
-males	16	12	40	13	9	9	17544	37,8
16-18 years old								
-females	17	25	45	7	2	4	23846	56,0
-males	19	15	41	12	7	6	18756	44,0
19-24 years old								
-females	12	24	47	9	3	5	15114	53,2
-males	14	14	44	15	7	7	13318	46,8
Difficulty in sleeping								
10-12 years old								
-females	8	7	38	25	14	8	8229	63,8
-males	10	5	31	25	22	7	4673	36,2
13-15 years old								
-females	11	10	41	24	10	5	29133	62,4
-males	13	6	31	27	18	5	17546	37,6
16-18 years old								
-females	12	13	45	20	7	2	23525	56,8
-males	15	8	34	23	16	3	17923	43,2
19-24 years old								
-females	11	16	46	19	6	1	15430	54,3
-males	14	12	39	21	12	2	13007	45,7
Suffering from headache								
10-12 years old								
-females	9	12	40	22	9	8	8867	64,8
-males	11	8	34	23	15	9	4825	35,2
13-15 years old								
-females	13	16	42	20	6	4	27817	62,5
-males	13	8	35	26	12	5	16657	37,5
16-18 years old								
-females	13	19	45	17	4	2	19145	56,1
-males	12	7	37	28	12	4	14984	43,9
19-24 years old								
-females	9	22	48	17	3	1	12368	53,5
-males	9	8	39	30	11	3	10737	46,5
Suffering from stomach pain								
10-12 years old								
-females	7	9	35	22	12	15	7978	64,7
-males	9	5	24	23	22	17	4351	35,3
13-15 years old								
-females	9	13	42	20	8	8	27147	63,6
-males	12	5	26	24	21	11	15546	36,4
16-18 years old								
-females	10	17	45	18	6	4	19364	56,6
-males	11	5	28	26	21	9	14836	43,4
19-24 years old								
-females	10	20	47	16	4	3	12836	54,0
-males	8	7	32	27	18	8	10926	46,0

Table 1 cont´d

Question/alternative	Yes, always	Yes, often	Yes, sometimes	No, seldom	No, never	don´t know	Number of responders	Sex, %
Feeling tense								
10-12 years old								
-females	6	7	32	21	11	23	7477	61,2
-males	10	4	28	20	18	19	4749	38,8
13-15 years old								
-females	9	14	38	16	6	16	25342	59,6
-males	14	6	32	18	15	14	17195	40,4
16-18 years old								
-females	13	24	40	11	4	9	18230	53,4
-males	15	9	38	16	13	9	15888	46,6
19-24 years old								
-females	14	25	46	7	3	5	13056	53,9
-males	14	13	43	14	8	7	11170	46,1
Poor appetite								
10-12 years old								
-females	7	6	30	21	17	19	7887	63,9
-males	9	4	23	21	25	18	4457	36,1
13-15 years old								
-females	8	8	36	21	16	11	26356	62,5
-males	11	4	23	22	29	12	15786	37,5
16-18 years old								
-females	7	9	41	21	16	6	17385	55,1
-males	10	4	26	21	31	8	14168	44,9
19-24 years old								
-females	5	9	42	22	18	4	10611	52,7
-males	7	5	30	22	30	6	9527	47,3
Feeling low								
10-12 years old								
-females	9	15	45	16	6	8	9458	65,5
-males	10	7	33	23	16	11	4978	34,5
13-15 years old								
-females	13	24	44	11	4	4	31107	63,6
-males	12	8	35	23	15	8	17793	36,4
16-18 years old								
-females	12	30	47	8	2	2	23174	58,0
-males	11	11	41	20	11	16	16799	42,0
19-24 years old								
-females	9	30	51	8	1	1	15731	55,4
-males	9	14	47	19	7	5	12665	44,6
Feeling dizzy								
10-12 years old								
-females	6	8	41	23	10	13	7372	64,2
-males	10	6	34	23	16	11	4101	35,8
13-15 years old								
-females	9	13	46	18	6	8	24737	62,1
-males	14	7	36	22	12	8	15106	37,9
16-18 years old								
-females	8	16	51	16	4	5	18125	56,1
-males	13	8	40	21	11	7	14189	43,9
19-24 years old								
-females	5	15	54	16	5	5	12704	54,5
-males	10	8	44	21	10	7	10592	45,5

TABLE 2

Adolescents and young adults, aged 15 - 20 years responding to the same questions about self perceived psycho-somatic health (SPH) at two occasions, 2007 and 2010, respectively.

Question/alternative	Females change in SPH 2007 vs 2010, p and interpretation	Number of female responders 2007 and 2010	Males change in SPH 2007 vs 2010, p and inter- pretation	Number of male responders 2007 and 2010
Difficulty in concentrating	0.04, better 2007	854, 1634	0.001, better 2007	808, 387
Difficulty in sleeping	0.004, better 2007	858, 1637	0.008, better 2007	818, 390
Suffered from headache	0.27, no difference	860, 1637	0.23, no difference	815, 388
Suffered from stomach ache	0.82, no difference	843, 1622	0.27, no difference	779, 380
Feeling tense	<0.0001, better 2007	837, 1599	<0.0001, better 2007	788, 382
Poor appetite	0.30, no difference	851, 1623	<0.0001, better 2007	797, 389
Feeling low	0.001, better 2007	864, 1635	0.0002, better 2007	804, 387
Feeling dizzy	0.29, no difference	838, 1618	0.16, no difference	

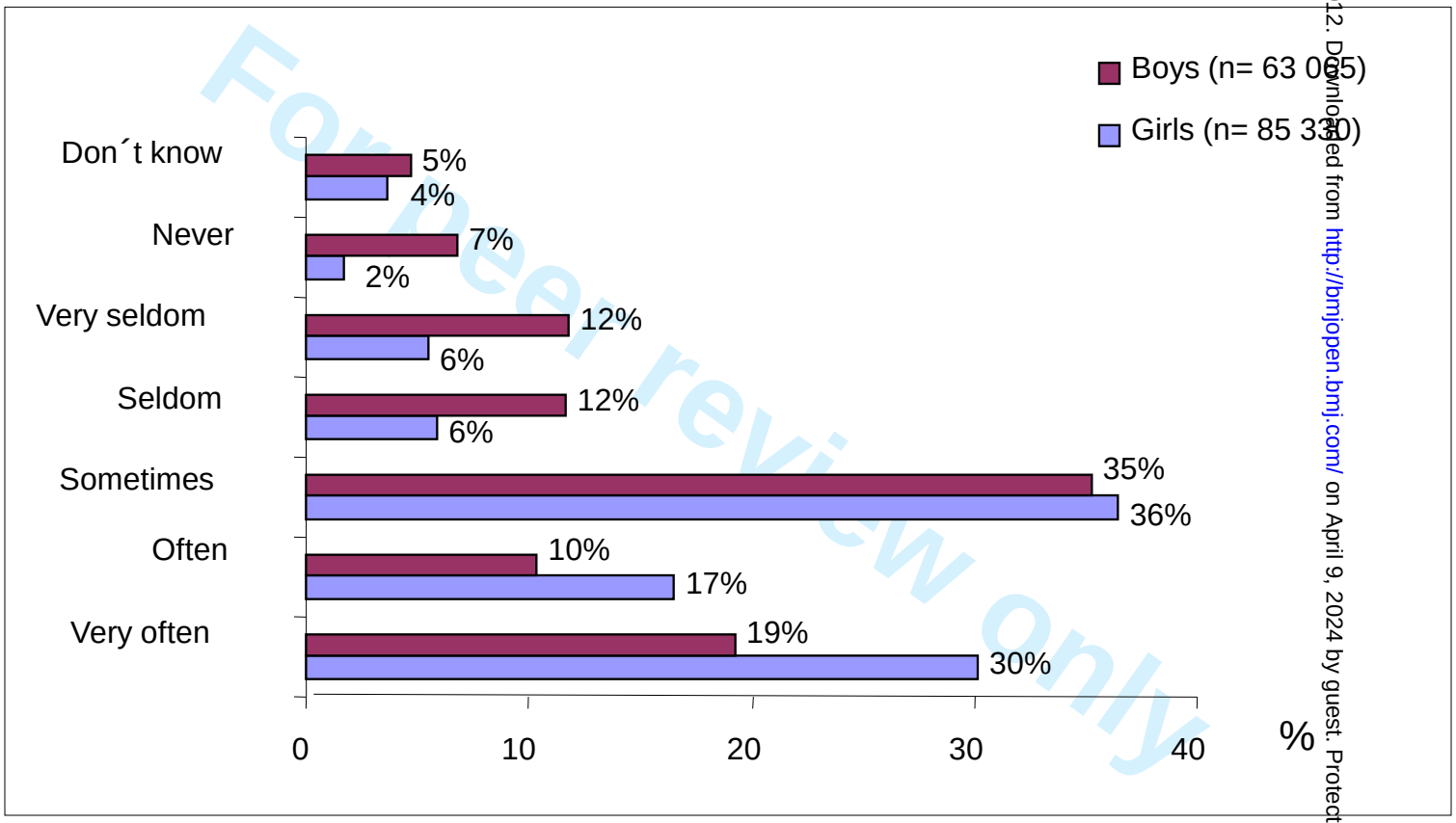
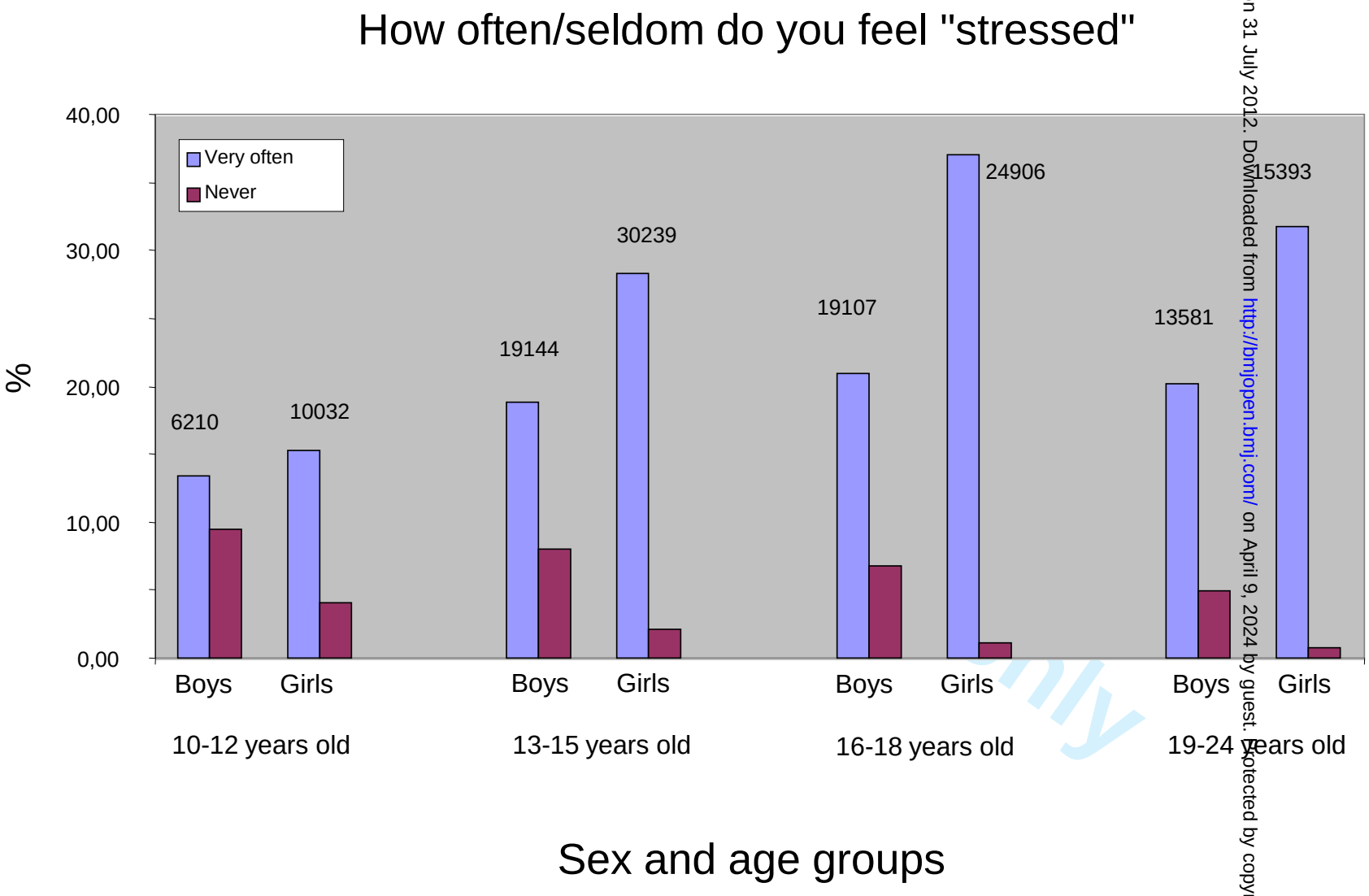


Fig 2



Self-perceived psychosomatic health in Swedish children, adolescents, and young adults: An Internet-based survey over time

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Self-perceived psychosomatic health in Swedish children, adolescents, and young adults: An Internet-based survey over time

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Running title: Stress in youth examined on the Internet

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Summary

Article focus:

- Using the Internet to investigate self-perceived psycho-somatic health in the young in Sweden
- Does psychosomatic health improve in adolescents between 2007 and 2010

Key messages

- A high percentage of young subjects responded that they felt stressed very often/often; the numbers were higher for females than for males
- older teenaged females had more psychosomatic complaints compared to males
- both sexes had a slightly better self-perceived health status in 2007

Strengths and limitations

- Very large cohort of both children, adolescents and youn adults from the whole of Sweden
- All subjects responded completely voluntarily.
- There may be a selection bias, given that we do not know the psychosomatic health in subjects who are not logged onto the website.

Abstract

Objectives: We used the Internet to investigate self-perceived psychosomatic health in large groups of young people (10–24 years old) in Sweden, and to analyze trends during 2005 and 2010.

Design: cross-sectional

Setting: Internet survey across Sweden. Validated questionnaires were launched on the Internet by a recognized community site in a controlled manner.

Participants: When subjects logged in to their personal area, they could then answer questions regarding their health status with full freedom and anonymity.

Results: A high percentage of young subjects responded that they felt stressed very often/often; the numbers were higher for females than for males. The self-perceived health questionnaire revealed that older teenaged females had more psychosomatic complaints compared to males of similar ages; in contrast, in 10–12-year-old children, the percentage of psychosomatic complaints was similar for males and females. When we compared results obtained in 2010 to those obtained in 2007, we found that young people of both sexes had a slightly better self-perceived health status in 2007.

Conclusions: This novel Internet-based survey is a valuable tool for examining self-perceived health in young people over a broad range of ages. A relatively high percentage of young people, particularly females 16–18 years of age, had psychosomatic complaints that did not seem to improve from 2007 to 2010. A considerable worsening of these complaints occurred from the age of 12 years and onward in both sexes.

Key words: self-perceived health, psychosomatic, children, adolescents.

Introduction

The situation of children has changed dramatically over the past decades. Several conditions in today's modern information society have, in multiple ways, exposed children to seemingly increased levels of stress [1-2]. Lupien et al. pointed out that risk factors for the development of stress reactions depend primarily on the genetic vulnerability of the individual, the exposure to adverse life events, the socioeconomic situation, disturbances in important relationships, problems with school, and the timing of stressful events (3). Importantly, the development of stress reactions in young people is, to a great extent, gender dependent. Hence, it seems plausible that several factors, both psychological and physical, play important roles in children's well-being and ill health, with salient implications for future health and disease.

Given the recent development of higher frequencies of reported ill health in children, adolescents, and young adults, particularly in older teenage girls, both in Sweden and internationally (4-9), the purpose of this study was to obtain reliable information, both at a given time point and as a trend analysis, about perceived health in a wide range of ages of Swedish subjects 10–24 years of age. This was accomplished with a questionnaire comprising an eight-item scale of subjective health complaints and a general question about stress. The questionnaire was completed by a large number of subjects on the Internet site LunarStorm and its successor Wyeth. LunarStorm was one of the first web communities to be established in Sweden. Using a web-designed protocol, our primary aim was to explore psychosomatic health problems among children and adolescents in Sweden, focusing on sex and age differences. To our knowledge, this study is the first to use the Internet to examine self-perceived health in large cohorts of children, adolescents, and young adults on a completely voluntary

basis. Furthermore, we explored possible changes in the percentages of self-reported health complaints over a 3-year period from 2007 to 2010.

Methods

Data collection was performed with a self-administered Internet-based questionnaire consisting of three parts: (1) a single question about “stress,” launched on the Internet on a single day in January 2005. (2) Eight questions about self-perceived health that were completed in the period from 26 May to 28 June 2005, delivered on eight separate days with one question each day. (3) The same eight questions, delivered together to a smaller group of statistically randomly selected 15–20 year olds on the same day in May 2007, and then again to a new age-matched group of randomly selected adolescents and young adults in May 2010. The subjects had complete freedom regarding whether to fill out the questionnaire or to abstain.

Apart from the single question about stress, the aforementioned eight questions were developed and tested for reliability and used by the Swedish National Board of Health and Welfare (www.socialstyrelsen.se) in studies of the psychological health and well-being of children and adolescents. The composite measure of subjective health (7) comprises the following items: have difficulty concentrating, have difficulty sleeping, suffer from headaches, suffer from stomachaches, feeling tense, poor appetite, feeling low, and feeling dizzy. The response categories for all of these items, which are in the form of questions, are: don’t know; no, never; no, seldom; yes, sometimes; yes, often; and yes, always. The item about stress was described as “how often/seldom do you feel stressed?” and the response categories were: yes, very often; yes, often; yes, sometimes; no, seldom; no, very seldom, no, never; and don’t know.

Initially, we placed one question per day on LunarStorm's website (2005). The question was shown following log-in by the members of LunarStorm, and only one answer per log-in was allowed and counted. We focused on children, adolescents, and young adults ranging from 10 to 24 years old. The percentage of LunarStorm members of each age class in Sweden ranged from 20% to 88%, with the highest values (>80%) for adolescents between 13 and 16 years of age (Statistics Sweden, www.scb.se).

The number of 10–24-year-old responders to the single question about stress was 148,395 (85,330 girls). The first set of eight questions was placed on the website 4 months later. Given that these questions were placed one at a time, the response frequency varied between 12,000 and 45,000 subjects, who were mainly in the age groups 10–12 and 13–18 years, respectively, with similar response frequencies for all eight questions. The eight items were then released on the Internet on a single day in 2007 to a group of 15–20-year-old subjects who were randomly selected by the community websites using statistical methods; thus, children and younger adolescents were not included as they were in the protocol that consisted of one question on a single day. We chose to focus on 15–20 year olds because of their higher response rate. Given the very large number of responders to the questions that were launched on separate days, we were able to divide the subjects not only into gender groups, but also into various age groups (Table 1).

In another Internet-based protocol to determine trends of self-perceived health using the same eight questions described above, subjects were randomly selected in both

May 2007 and May 2010 to voluntarily respond to the questions. These groups comprised approximately 1,500 subjects aged 15–20 years (Table 2).

Ethical approval was obtained from the chairman of the review board. Putting questionnaires on the Internet does not require ethical approval from a committee according to the rules. However, we choose to discuss these issues thoroughly with the chairman and will full approval.

Statistical information and analysis

At the time of our investigations in 2005 and 2007, LunarStorm was the largest Internet community in Sweden. It had 1.3 million active members and approximately 360,000 unique visitors per day, who spent about 40 minutes on the site (TNS Gallup/Red Measure, Nielsen/Net Ratings). Of 15–20 year olds in Sweden, 83% were LunarStorm members, and 25 out of 30 pupils in every secondary school class were members (Lunarworks AB/SCB). The gender distribution of members was 53% females.

Due to the lack of normal distribution of the material and the categorical character of the questionnaire, nonparametric tests were used. These include Mann–Whitney U test and Kruskal–Wallis and chi-square tests. Each of the alternative responses to the questions was assigned a number, which was multiplied by the response frequency and then averaged. The answer “don’t know” was not included in the statistical calculations. Statistical significance was considered to be $p < 0.05$.

Results

Consistently more girls answered questions, and there was a general pattern in which the severity of the self-perceived health reported by the subjects declined as they get

older. The peak of problems experienced appeared to occur in adolescents aged 16–18 years, and, in addition, there were even more perceived problems in females.

Item about stress

The population who answered the single question about stress comprised approximately 148,000 individuals, of whom 57% were females. The vast majority of this population was between 10 and 24 years of age. When analyzing the total population, we found that 30% of the females and 19% of the males considered themselves to be stressed very often (Figure 1). Similarly, the response “yes, often” was provided more often by females: 17% vs. 10% in males ($p < 0.0001$). When the 10–24-year-old population was divided into age subgroups, we found that 16–18-year-old males and females reported the highest degree of stress (very often): 22% and 37% for males and females, respectively (Figure 2, $p < 0.0001$). The lowest number of subjects responding “yes, often” to stress was in the 10–12-year-old group. Consistently, females were statistically significantly more likely to report higher levels of stress (very often and often) than males from 10 to 24 years of age. The percentage of males responding “yes, very often” to the stress question remained relatively constant at 20% from 13 to 24 years of age, while the percentage of females responding “yes, very often” increased up until 16–18 years old and levelled off for those who were 19–24 years old. However, this older female group still showed statistically significantly higher values than males of the same age (Figure 2). Males of all ages chose the alternative response “no, never” to the question about stress statistically more frequently than females (Figure 2).

Eight questions presented on separate days to 10–24 year olds on the Internet (Table 1)

When all of the possible responses to all eight questions were considered, we found that males of all age groups scored higher in terms of self-perceived health compared to females ($p < 0.0001$). The only exceptions in which there were no differences between males and females occurred in the 10–12-year-old group regarding difficulty concentrating ($p = 0.11$), and in the 19–24-year-old group regarding difficulty sleeping ($p = 0.16$).

The influence of age, as judged from the four age groups and an analysis of responses to all of the questions (except for the question regarding poor appetite), revealed that the older the subjects, the poorer their self-perceived health ($p < 0.0001$). Both females and males demonstrated poorer self-perceived health the older they were ($p < 0.0001$ for both, except for $p = 0.04$ for poor appetite in females). However, males reported less headache ($p = 0.02$) and better appetite ($p = 0.003$) with increasing age. When we adjusted for the differences in sex, we found poorer self-perceived health with increasing age ($p < 0.0001$), with the exception of poor appetite ($p = 0.52$), for which males and females had opposite overall responses, as described above. Likewise, when we adjusted for differences in age, we found better self-perceived health in males compared to females ($p < 0.0001$).

Eight questions regarding self-perceived health presented together on the Internet in 2007 and 2010

Males reported better self-perceived health than females for all eight questions in the 2007 questionnaire (Figure 3, $p < 0.0001$). The results were similar in 2010, with males reporting better self-perceived health than females regarding headache, stomachache,

feeling tense, poor appetite, feeling low, and feeling dizzy (Figure 3, $p < 0.0001$), as well as difficulty sleeping ($p = 0.002$). However, the difference between males and female regarding difficulty concentrating was not statistically significant ($p = 0.06$). There were subtle differences between the overall responses to the 2007 and 2010 questionnaires. Males demonstrated better self-perceived health in 2007 vs. 2010 regarding feeling low, poor appetite, feeling tense, and difficulty sleeping and concentrating (Table 2). Females presented a similar pattern of better self-perceived health, with the exception of poor appetite (no change). The items stomachache, headache, and feeling dizzy remained unchanged from 2007 to 2010 for both sexes (Table 2).

Discussion

This study constituted a large web community–based survey of self-perceived psychosomatic health in young people 10–24 years of age, using well-established questions (6-8). We found marked differences between the sexes, with females reporting higher degrees of stress and psychosomatic symptoms compared to males. These symptoms appeared to be most pronounced between 16 and 18 years of age, and then to decline, supporting and extending the results of Hagquist (7). Similar findings using the same eight questionnaire items were reported previously (6,7); however, these were smaller regional studies that administered the questionnaires in person (the questionnaires have been handed out in schools). Major advantages of the present study are: (1) Subject can log into her or his own “LunarStorm corner” and choose voluntarily to fill out the questions on the Internet. They are thus more likely to be giving honest answers. (2) Many subjects of various ages responded to the questions.

When the single question regarding stress was placed on the LunarStorm website, females reported high degrees of stress (“very often” and “often”; Figures 1 and 2) more often than males, and they chose the response alternative “never” less frequently than males. The difference between female and male responses regarding high levels of stress was statistically significant. This pattern was supported by our eight follow-up questions, either asked collectively or one at a time; females reported more sadness, poor appetite, feeling tense, stomachache, headache, and difficulty sleeping and concentrating compared to males. As pointed out previously (7,8), females between 16 and 18 years of age are more likely than males of the same age to report feeling stressed. Our results further show that although fewer young people 19–24 years of age reported feeling stressed very often compared to 16 to–18 year olds, the number of females reporting that they felt stressed very often was still high (33% vs. 38%, respectively, for 19–24-year-old and 16–18-year-old females). The percentage of males reporting that they felt stressed very often was approximately 20%; this percentage was remarkably constant from 13 up to 24 years of age. In contrast, 13% of males and 15% of females who were 10–12 years old reported being stressed very often. Hence, in this age group, high levels of stress were reported less often and the discrepancy between the sexes was much lower than for older children and adolescents.

The present study also administered the same eight questions regarding psychological and psychosomatic health in 2007 and 2010. For several, but not all, of the questions that were asked, the self-perceived health was better in 2007 compared to 2010 for both males and females (Table 2 and Figure 3), perhaps reflecting the financial crisis

that emerged in 2008. Responses to the questions regarding stomachache, headache, and feeling dizzy did not change significantly between 2007 and 2010 for either sex.

Although the changes between 2007 and 2010 were quite small and the time elapsed perhaps too short, we did note similar degrees of differences between the responses of males and females in 2005, 2007, and 2010. Self-perceived health was undoubtedly worse for females compared to males, irrespective of age; this finding is supported by the results of Osika et al. (9), who used Beck Youth Inventory questionnaires.

Our data, together with the results of previous studies (4,7-9,10-11), point unequivocally to the presence of hampered psychological and psychosomatic health in the young, and the prevailing situation and trend does not seem to be improving. The psychosomatic health of young females is of particular concern, given the increase in complaints that appears to have taken place over the past 20 years, as indicated by surveys in Sweden (7). Although the figures are also high for males, they do not appear to have increased during the same elapsed period. However, the figures regarding alcohol problems, criminality, and suicide are much higher for males than for females in the 16–24-year-old age group (6).

Given that the majority of the examined subjects in the present study are of school age, the school environment is an important factor to consider with regard to the well-being of children and adolescents. Previous reports have established links between the environment at school and the psychological and psychosomatic symptoms of schoolchildren (5,12). Indeed, Hjern et al. (10) demonstrated an association between school stressors, such as harassment by peers, schoolwork pressure, and being

treated poorly by teachers, and psychosomatic pain and psychological problems, reflected as sadness, irritability, and feeling unsafe and nervous.

Methodological considerations and limitations

The eight-item scale that we used was validated in several studies as an appropriate means of estimating the subjective health complaints of children and adolescents. The instrument was also examined with the Rasch model, for which the property of invariance is essential (13,14). The Rasch model revealed that from a general level of analysis, the eight items were invariant among students with good health and among those with bad health. Importantly, these eight questions also work invariantly across time; i.e., there is no differential item functioning with respect to the year of investigation, which is a prerequisite for repeated analysis, as in the present study.

There are few data available regarding Internet-based surveys of psychological health among young people; hence, there are few validation analyses. However, a study by Mangunkusumu et al. (15) demonstrated good agreement between responses to questionnaires that were handed out manually and those administered via the Internet. Notably, the Internet approach received more favorable evaluations, even though it also took place in a school milieu. A major advantage of the present study was that the subjects could choose whether or not to answer the questions while in a familiar and comfortable environment. Furthermore, administrative factors such as data transcription, the risk of left-out values and “odd” answers, and the concern that other people might read the answers can be overcome by computer- and Internet-based surveys. Hence, Internet surveys assessing psychological health and well-being issues appear to be quite suitable for use in young people.

Compared to the response rates obtained from telephone or mail questionnaires, the number of responders per day may seem somewhat low. We received responses from between 100,000 and 150,000 individuals per day; this represents approximately 36% of the entire population of members (1.2 million). Roughly 350,000 people logged in on a given day, raising the possibility of selection bias. However, the response rate obtained at LunarStorm was very high for such a generalized Internet-based survey.

Conclusion

This novel Internet-based survey is a valuable tool for examining self-perceived health in young people over a broad range of ages. A relatively high percentage of young people, particularly females 16–18 years of age, had psychosomatic complaints that did not seem to improve from 2007 to 2010. A considerable worsening of these complaints occurred from the age of 12 years and onward in both sexes.

Thus, strong emphasis should be placed on improving life conditions during early phases, such as in school environments, and later on facilitating the transition into early adulthood.

Funding

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Data Sharing

There is no additional data available.

Contributorship

PF had the main responsibility for designing, analysing data and drafting the manuscript. CH and WO took active part in designing questions regarding psychosocial health, reviewing data analysis and made important commentaries on the text. Authors approve the present version to be published.

Competing interests

None.

Figure legends

Fig 1. Bars depict percentage number of responses (from alternatives never to very often) to the question “How often/seldom do you feel stressed?” for 10 to 24 year-old females and males. Total number of respondents was 148 395. For statistics, see text.

Fig 2. Bars demonstrate percentage number of responses, expressed as never and very often, to the question “How often/seldom do you feel stressed?” divided by sex and age. Numbers in graph represent number of responding individuals. Statistics in text.

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TABLE 1

Proportion responders in % of 8 questions assessing self-perceived health asked on the web in May 2005. The column "don´t know" is not included in the subsequent calculations

Question/alternative	Yes, always	Yes, often	Yes, some-times	No, seldom	No, never	don´t know	Number of responders	Sex, %
Difficulty in concentrating								
10-12 years old								
-females	7	8	40	17	11	17	7526	63,4
-males	12	7	34	17	16	15	4341	36,6
13-15 years old								
-females	14	17	45	11	5	8	28889	62,2
-males	16	12	40	13	9	9	17544	37,8
16-18 years old								
-females	17	25	45	7	2	4	23846	56,0
-males	19	15	41	12	7	6	18756	44,0
19-24 years old								
-females	12	24	47	9	3	5	15114	53,2
-males	14	14	44	15	7	7	13318	46,8
Difficulty in sleeping								
10-12 years old								
-females	8	7	38	25	14	8	8229	63,8
-males	10	5	31	25	22	7	4673	36,2
13-15 years old								
-females	11	10	41	24	10	5	29133	62,4
-males	13	6	31	27	18	5	17546	37,6
16-18 years old								
-females	12	13	45	20	7	2	23525	56,8
-males	15	8	34	23	16	3	17923	43,2
19-24 years old								
-females	11	16	46	19	6	1	15430	54,3
-males	14	12	39	21	12	2	13007	45,7
Suffering from headache								
10-12 years old								
-females	9	12	40	22	9	8	8867	64,8
-males	11	8	34	23	15	9	4825	35,2
13-15 years old								
-females	13	16	42	20	6	4	27817	62,5
-males	13	8	35	26	12	5	16657	37,5
16-18 years old								
-females	13	19	45	17	4	2	19145	56,1
-males	12	7	37	28	12	4	14984	43,9
19-24 years old								
-females	9	22	48	17	3	1	12368	53,5
-males	9	8	39	30	11	3	10737	46,5
Suffering from stomach pain								
10-12 years old								
-females	7	9	35	22	12	15	7978	64,7
-males	9	5	24	23	22	17	4351	35,3
13-15 years old								
-females	9	13	42	20	8	8	27147	63,6
-males	12	5	26	24	21	11	15546	36,4
16-18 years old								
-females	10	17	45	18	6	4	19364	56,6
-males	11	5	28	26	21	9	14836	43,4
19-24 years old								
-females	10	20	47	16	4	3	12836	54,0
-males	8	7	32	27	18	8	10926	46,0

Table 1 cont´d

Question/alternative	Yes, always	Yes, often	Yes, sometimes	No, seldom	No, never	don´t know	Number of responders	Sex, %
Feeling tense								
10-12 years old								
-females	6	7	32	21	11	23	7477	61,2
-males	10	4	28	20	18	19	4749	38,8
13-15 years old								
-females	9	14	38	16	6	16	25342	59,6
-males	14	6	32	18	15	14	17195	40,4
16-18 years old								
-females	13	24	40	11	4	9	18230	53,4
-males	15	9	38	16	13	9	15888	46,6
19-24 years old								
-females	14	25	46	7	3	5	13056	53,9
-males	14	13	43	14	8	7	11170	46,1
Poor appetite								
10-12 years old								
-females	7	6	30	21	17	19	7887	63,9
-males	9	4	23	21	25	18	4457	36,1
13-15 years old								
-females	8	8	36	21	16	11	26356	62,5
-males	11	4	23	22	29	12	15786	37,5
16-18 years old								
-females	7	9	41	21	16	6	17385	55,1
-males	10	4	26	21	31	8	14168	44,9
19-24 years old								
-females	5	9	42	22	18	4	10611	52,7
-males	7	5	30	22	30	6	9527	47,3
Feeling low								
10-12 years old								
-females	9	15	45	16	6	8	9458	65,5
-males	10	7	33	23	16	11	4978	34,5
13-15 years old								
-females	13	24	44	11	4	4	31107	63,6
-males	12	8	35	23	15	8	17793	36,4
16-18 years old								
-females	12	30	47	8	2	2	23174	58,0
-males	11	11	41	20	11	16	16799	42,0
19-24 years old								
-females	9	30	51	8	1	1	15731	55,4
-males	9	14	47	19	7	5	12665	44,6
Feeling dizzy								
10-12 years old								
-females	6	8	41	23	10	13	7372	64,2
-males	10	6	34	23	16	11	4101	35,8
13-15 years old								
-females	9	13	46	18	6	8	24737	62,1
-males	14	7	36	22	12	8	15106	37,9
16-18 years old								
-females	8	16	51	16	4	5	18125	56,1
-males	13	8	40	21	11	7	14189	43,9
19-24 years old								
-females	5	15	54	16	5	5	12704	54,5
-males	10	8	44	21	10	7	10592	45,5

TABLE 2

Adolescents and young adults, aged 15 - 20 years responding to the same questions about self perceived psycho-somatic health (SPH) at two occasions, 2007 and 2010, respectively.

Question/alternative	Females change in SPH 2007 vs 2010, p and interpretation	Number of female responders 2007 and 2010	Males change in SPH 2007 vs 2010, p and inter- pretation	Number of male responders 2007 and 2010
Difficulty in concentrating	0.04, better 2007	854, 1634	0.001, better 2007	808, 387
Difficulty in sleeping	0.004, better 2007	858, 1637	0.008, better 2007	818, 390
Suffered from headache	0.27, no difference	860, 1637	0.23, no difference	815, 388
Suffered from stomach ache	0.82, no difference	843, 1622	0.27, no difference	779, 380
Feeling tense	<0.0001, better 2007	837, 1599	<0.0001, better 2007	788, 382
Poor appetite	0.30, no difference	851, 1623	<0.0001, better 2007	797, 389
Feeling low	0.001, better 2007	864, 1635	0.0002, better 2007	804, 387
Feeling dizzy	0.29, no difference	838, 1618	0.16, no difference	

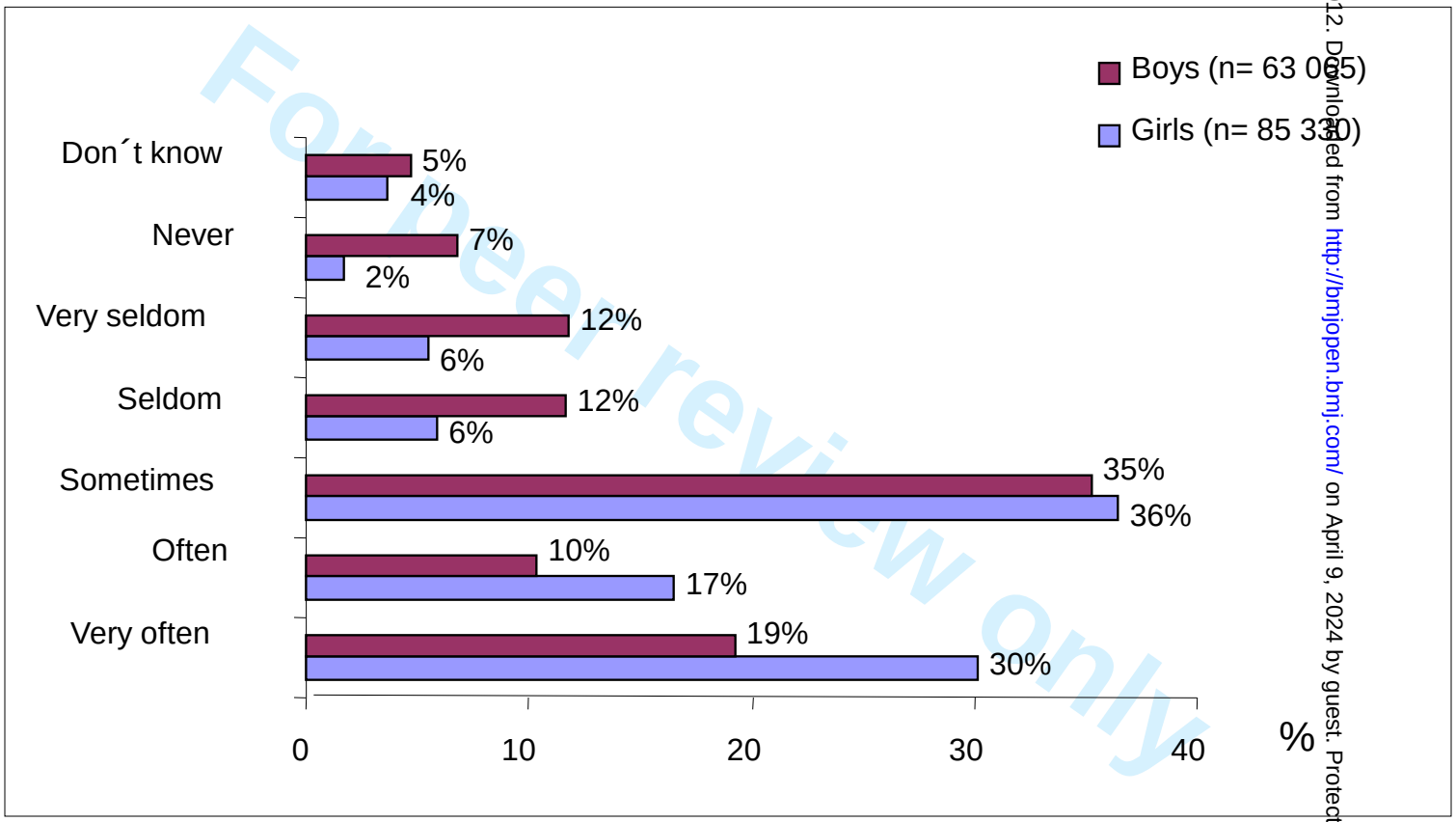
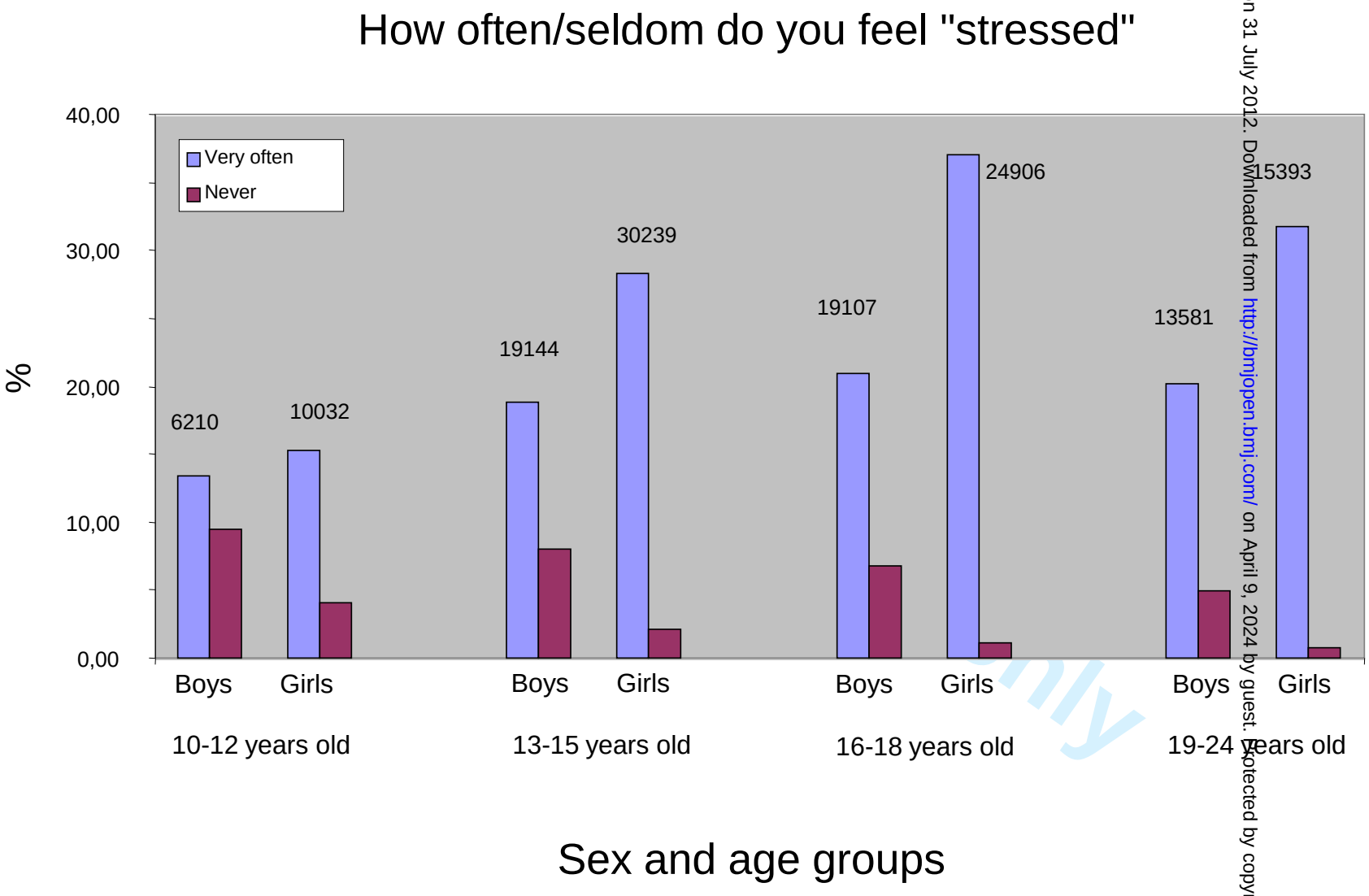


Fig 2



Self-perceived psychosomatic health in Swedish children, adolescents, and young adults: An Internet-based survey over time

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Running title: Stress in youth examined via the Internet

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Summary

Article focus:

- Examining self-perceived health and stress in large cohorts of children, adolescents, and young adults
- Examining whether psychosomatic health deteriorated in adolescents between 2007 and 2010.
- Using a large web-based community on the Internet to investigate self-perceived psychosomatic health in Swedish youth.

Key messages

- A high percentage of young subjects responded that they felt stressed very often/often, and the numbers were higher for females than for males.
- Older teenaged females had more psychosomatic complaints than males did.
- Both sexes reported a slightly worse self-perceived health status in 2010 than in 2007.
- Novel internet-based community site surveys are feasible for assessing self-perceived health in the young.

Strengths and limitations

- The study examined a very large cohort of children, adolescents and young adults from throughout Sweden.
- All subjects responded completely voluntarily.
- There may be a selection bias, given that we do not know the psychosomatic health of individuals who were not logged onto the website.
- Participation in the survey was completely anonymous; thus, we could not perform additional interviews to study the web questions' validity in this population.

Abstract

Objectives: We investigated self-perceived psychosomatic health in large groups of young people (10 to 24 years of age) in Sweden and analysed trends during the years 2005 to 2010 via a large community website.

Design: Cross-sectional

Setting: Internet survey across Sweden. Validated questionnaires were launched on the Internet by a recognised community site in a controlled manner.

Participants: Eligible study participants were invited to answer questions about their health status with full anonymity as they logged in to their personal area on the website.

Results: A high percentage of young subjects responded that they felt stressed very often/often; the numbers were higher for females (47%) than for males (29%). The self-perceived health questionnaire revealed that older teenaged females had more psychosomatic complaints than did males of similar ages; in contrast, among 10- to 12-year-old children, the percentage of psychosomatic complaints was similar for males and females. When we compared the results obtained in 2010 with those obtained in 2007, we found that young people of both sexes had a slightly better self-perceived health status in 2007.

Conclusions: A high percentage of young people, particularly females 16 to 18 years of age, had psychosomatic complaints that did not seem to improve between 2007 and 2010. A considerable worsening of these complaints occurred from the age of 12 years onwards in both sexes. When directing questions to a large community, Internet-based surveys appear to be valuable tools.

Keywords: Self-perceived health, psychosomatic, children, adolescents

Introduction

Children's life situations have changed dramatically over the past decades. Several conditions in today's modern information-based society have exposed children to seemingly increased levels of stress in multiple ways [1-2]. Lupien et al. noted that risk factors for the development of stress reactions depend primarily on an individual's genetic vulnerability, exposure to adverse life events, socioeconomic situation, disturbances in important relationships, problems with school, and the timing of stressful events (3). Importantly, the development of stress reactions in young people is, to a great extent, gender-dependent (4,5,6). Thus, it seems plausible that several factors, both psychological and physical, play important roles in children's well-being and ill health, with salient implications for future health and disease (7).

Given the recent development of higher frequencies of reported ill health in children, adolescents, and young adults, particularly older teenage girls, in Sweden and internationally (8-13), the aim of this study was to obtain reliable information both at a given time point and as a trend analysis about perceived health in Swedish subjects aged 10 to 24 years. To achieve this purpose, we needed a strategy that would feasibly allow us to ascertain a large number of respondents. Donker et al. (14) used screening questionnaires for common mental disorders and recommended that such questionnaires be administered via the Internet, which offers quick and easy access to a large number of users at a low cost. The screening must be brief, as subjects are more likely to undergo screening if it is short, quickly completed, and easy to read (14). Our primary aim was to explore psychosomatic health problems among children and adolescents, focusing on sex and age differences, using a web-based protocol. We

accomplished this using a questionnaire composed of an eight-item scale of subjective health complaints and a general question about stress.

The questionnaire was completed by a large number of subjects over the Internet site LunarStorm and its successor, Wyeth. LunarStorm was one of the first web communities to be established in Sweden. To our knowledge, this study is the first to use the Internet to examine self-perceived health and stress in large cohorts of children, adolescents, and young adults on a completely voluntary basis. Furthermore, we explored possible changes in the percentages of self-reported health complaints over a three-year period from 2007 to 2010.

Methods

Data were collected via a self-administered Internet-based questionnaire consisting of three parts: (i) a single question about "stress," launched on the Internet on a single day in January 2005. (ii) Eight questions about self-perceived health that were completed between 26 May and 28 June 2005. One question was delivered on each of eight separate days. (iii) The same eight questions, delivered to a smaller group of randomly selected 15- to 20-year-olds on the same day in May 2007 and then again to a new age-matched group of randomly selected adolescents and young adults in May 2010. The subjects had complete freedom regarding whether to complete or abstain the questionnaire.

Apart from the single question about stress, the aforementioned eight questions were developed and tested for reliability and used by the Swedish National Board of Health and Welfare (www.socialstyrelsen.se) in studies of the psychological health and well-being of children and adolescents. The composite measure of subjective health (4) is

comprised of the following items: difficulty concentrating, difficulty sleeping, suffers from headaches, suffers from stomach-aches, feels tense, poor appetite, feels low, and feels dizzy. The response categories for all of these items, which were delivered in question form, were “don’t know”; “no, never”; “no, seldom”; “yes, sometimes”; “yes, often”; and “yes, always”. The item about stress was “How often/seldom do you feel stressed?”, and the response categories were “yes, very often”; “yes, often”; “yes, sometimes”; “no, seldom”; “no, very seldom”; “no, never”; and “don’t know”. The scoring procedure has been psychometrically analysed using the Rasch model (15), which is based on the same questionnaire that was used in the current study. The outcomes from the Rasch analysis of the PSP scale have been reported in a previous paper (16). The analysis confirmed the appropriateness of considering somatic and psychological problems as interacting parts that constitute a higher-order, unidimensional construct (psychosomatic health). The scale showed valid psychometric properties and met the measurement requirements of invariance and proper item categorisation.

Initially, we placed one question per day on LunarStorm’s website (2005). Members saw the question after log-in, and only one answer per log-in was allowed and counted. We focused on children, adolescents, and young adults from 10 to 24 years old. The percentage of LunarStorm members in each age class in Sweden ranged from 20% to 88%, with the highest values (>80%) for adolescents between 13 and 16 years of age (Statistics Sweden, www.scb.se).

The single question about stress received 148,395 responses (85,330 girls) from 10- to 24-year-olds. The first set of eight questions was placed on the website 4 months

later. Given that these questions were placed one at a time, the response frequency varied between 12,000 and 45,000 subjects, who were mainly in the 10- to 12-year-old and 13- to 18-year-old age groups, respectively; the response frequencies for all eight questions were similar. The eight items were then released on the Internet on a single day in 2007 to a group of 15- to 20-year-old subjects who were randomly selected by the community websites using statistical methods. Children and younger adolescents were not included, as they were in the protocol that presented one question per day. We chose to focus on 15- to 20-year-olds because of their higher response rate. Because questions released on separate days would attract a very large number of responders, we were able to divide the subjects not only into gender groups but also into various age groups (Table 1).

In another Internet-based protocol using the same eight questions described above to determine self-perceived health trends, the subjects were randomly selected in both May 2007 and May 2010 to voluntarily respond to the questions. These groups comprised approximately 1,500 subjects aged 15 to 20 years (Table 2).

Ethical approval was obtained from the chairman of the review board. According to the ethical guidelines, posting questionnaires on the Internet does not require ethical approval from a committee. However, we choose to discuss these issues thoroughly with the chairman and received full approval.

Statistical analyses

At the time of our investigations in 2005 and 2007, LunarStorm was the largest Internet community in Sweden. It had 1.3 million active members and approximately 360,000 unique visitors per day who spent approximately 40 minutes per visit on the

site (TNS Gallup/Red Measure, Nielsen/Net Ratings). Eighty-three per cent of 15- to 20-year-olds in Sweden were LunarStorm members, and 25 out of 30 pupils in every secondary school class were members (Lunarworks AB/SCB). The gender distribution of members was 53% females.

Due to the lack of normal distribution of the material and the categorical character of the questionnaire, nonparametric tests were used. These included the Mann-Whitney U test and the Kruskal-Wallis and chi-squared tests. Each of the possible responses to the questions was assigned a number, which was multiplied by the response frequency and then averaged. The answer "don't know" was not included in the statistical calculations. Statistical significance was considered when $p < 0.05$.

Results

Consistently more girls answered the questions, and there was a general pattern in which the severity of the self-perceived health reported by the subjects declined with age. The peak of problems experienced appeared to occur in adolescents aged 16 to 18 years, and females perceived the most problems.

Item about stress

Approximately 148,000 individuals, 57% of whom were females, answered the single question about stress. The vast majority of this population was between 10 and 24 years old. When analysing the total population, we found that 30% of the females and 19% of the males considered themselves stressed very often (Figure 1). Similarly, the response "yes, often" was provided more often by females: 17% vs. 10% in males ($p < 0.0001$). When the 10- to 24-year-old population was divided into age subgroups, we found that 16- to 18-year-old males and females reported the highest degree of stress

(very often): 22% for males and 37% for females (Figure 2, $p < 0.0001$). The lowest number of subjects responding "yes, often" to stress was in the 10- to 12-year-old group. Consistently, females were significantly more likely to report higher levels of stress ("very often" and "often") than males from 10 to 24 years of age. The percentage of males responding "yes, very often" to the stress question remained relatively constant at 20% from 13 to 24 years of age, while the percentage of females responding "yes, very often" increased until they reached 16 to 18 years old and levelled off for those who were 19 to 24 years old. However, this older female group still showed statistically significantly higher values for self-perceived stress than males of the same age (Figure 2). Males of all ages chose the alternative response "no, never" to the question about stress statistically more frequently than females (Figure 2).

Eight questions presented via the Internet on separate days to 10- to 24-year-olds (Table 1)

When all of the possible responses to all eight questions were considered, we found that males of all age groups scored higher in terms of self-perceived health compared with females ($p < 0.0001$). The only exceptions in which there were no differences between males and females occurred in the 10- to 12-year-old group regarding difficulty concentrating ($p = 0.11$) and in the 19- to 24-year-old group regarding difficulty sleeping ($p = 0.16$).

An analysis of the four age groups' responses to all of the questions (except for the question regarding poor appetite) revealed that the older the subjects, the poorer their self-perceived health ($p < 0.0001$). Both females and males demonstrated poorer self-perceived health the older they were ($p < 0.0001$ for both, except for $p = 0.04$ for poor

appetite in females). However, males reported fewer headaches ($p = 0.02$) and better appetite ($p = 0.003$) with increasing age. When we adjusted for the differences in sex, we found poorer self-perceived health with increasing age ($p < 0.0001$), with the exception of poor appetite ($p = 0.52$), which received opposite overall responses for males and females, as described above. Similarly, when we adjusted for differences in age, we found better self-perceived health in males than in females ($p < 0.0001$).

Eight questions regarding self-perceived health presented together on the Internet in 2007 and 2010

Males reported better self-perceived health than females for all eight questions in the 2007 questionnaire (Figure 3, $p < 0.0001$). The results were similar in 2010, with males reporting better self-perceived health than females regarding headache, stomach-ache, feeling tense, poor appetite, feeling low, and feeling dizzy (Figure 3, $p < 0.0001$) as well as difficulty sleeping ($p = 0.002$). The difference between males and female regarding difficulty concentrating was not statistically significant ($p = 0.06$). There were subtle differences between the overall responses to the 2007 and 2010 questionnaires. Males demonstrated better self-perceived health in 2007 vs. 2010 regarding feeling low, poor appetite, feeling tense, and difficulty sleeping and concentrating (Table 2). Females presented a similar pattern of better self-perceived health, with the exception of poor appetite (no change). The items stomach-ache, headache, and feeling dizzy remained unchanged from 2007 to 2010 for both sexes (Table 2).

Discussion

We found marked differences between the sexes regarding psychosomatic symptoms, with females reporting higher degrees of stress compared with males across the large age span between 10 and 24 years of age. These symptoms appeared to be most pronounced between 16 and 18 years of age and then declined, supporting and extending the results of Hagquist (4). Similar findings using the same eight questionnaire items were reported previously (4,10); however, these findings came from smaller regional studies that administered the questionnaires in person (by distributing them in schools). The present study used the Internet to assess psychosomatic health in young people using well-established questions (4,10,11), with the beneficial result of having a high number of respondents in each age and sex category. Another advantage was that each subject could log into her or his own "LunarStorm corner" and voluntarily choose to complete the questions on the community site, which would make the subjects more likely to provide honest answers.

When the single question regarding stress was placed on the LunarStorm website, females reported high degrees of stress ("very often" and "often"; Figures 1 and 2) more often than males, and they chose the response alternative "never" less frequently than males. The difference between female and male responses regarding high levels of stress was statistically significant. This pattern was supported by our eight follow-up questions, which were either asked collectively or one at a time. Females reported more sadness, poor appetite, feeling tense, stomach-ache, headache, and difficulty sleeping and concentrating compared with males. As noted previously (4,11), females between 16 and 18 years of age are more likely than males in the same age group to report feeling stressed. Furthermore, our results show that

although fewer young people aged 19 to 24 years reported feeling stressed very often compared with 16- to 18-year-olds, the number of females reporting that they felt stressed very often was still high (33% for 19- to 24-year-old females vs. 38% for 16- to 18-year-old females). The percentage of males reporting that they felt stressed very often was approximately 20%; this percentage was remarkably constant from 13 to 24 years of age. In contrast, 13% of males and 15% of females aged 10 to 12 years old reported being stressed very often. Thus, in this age group, high levels of stress were reported less often, and the discrepancy between the sexes was much lower than for older children and adolescents.

The present study also administered the same eight questions regarding psychological and psychosomatic health in 2007 and 2010. For several, but not all, of the questions, self-perceived health was better in 2007 than in 2010 for both males and females (Table 2 and Figure 3), perhaps reflecting the financial crisis that emerged in 2008. Responses to the questions regarding stomach-ache, headache, and feeling dizzy did not change significantly between 2007 and 2010 for either sex.

Although the changes between 2007 and 2010 were quite small, and the time elapsed was perhaps too short, we did note similar differences between males' and females' responses in 2005, 2007, and 2010. Self-perceived health was undoubtedly worse for females than for males, irrespective of age; this finding is supported by earlier studies (5,6) and the results of Osika et al. (12), who used Beck Youth Inventory questionnaires.

Our data, together with the results of previous studies (4,8,12,13,17), point unequivocally to impaired self-reported psychological and psychosomatic health in the young, and the prevailing situation and trend do not seem to be improving. The psychosomatic health of young females is of particular concern, given the increase in complaints that appears to have occurred over the past 20 years, as indicated by surveys in Sweden (4). Although the figures are also high for males, they do not appear to have increased during the same elapsed period. However, the figures regarding alcohol problems, criminality, and suicide are much higher for males than for females in the 16- to 24-year-old group (10).

Given that the majority of the subjects in the present study school-aged, the school environment is an important factor to consider. Previous reports have established links between the school environment and the psychological and psychosomatic symptoms of schoolchildren (9,18). In fact, Hjern et al. (13) demonstrated an association between school stressors, such as harassment by peers, schoolwork pressure, and being treated poorly by teachers, as well as psychosomatic pain and psychological problems, reflected as sadness, irritability, and feeling unsafe and nervous.

Methodological considerations and limitations

The eight-item scale we used was validated in several studies as an appropriate means of estimating the subjective health complaints of children and adolescents. The instrument was also examined with the Rasch model, for which invariance is essential (16,19). The Rasch model revealed that from a general level of analysis, the eight items were invariant among students with good health and among those with bad health. Importantly, these eight questions also work invariantly across time; i.e., there

is no differential item functioning with respect to the year of investigation, which is a prerequisite for repeated analysis, as in the present study.

There are few data available regarding Internet-based surveys of psychological health among young people; thus, there are few validation analyses. Donker et al. (14) validated a brief web-based screening questionnaire for common mental disorders with follow-up phone interviews, using a "gold standard' interview guide to assess the presence of DSM-IV disorders in the previous 6 months. Their questionnaire screened for common mental disorders. However, the subjects in the present study could not be identified; thus, such a validation was not possible.

A study by Mangunkusumu et al. (20) demonstrated good agreement between responses to questionnaires that were handed out manually and those administered via the Internet. Notably, the Internet approach received more favourable evaluations, even though it also took place in a school milieu. A major advantage of the present study was that the subjects could choose whether to answer the questions while in a familiar private and comfortable environment. Furthermore, such administrative factors as data transcription, the risk of excluded values and "odd" answers, and the concern that other people might read the answers can be overcome by computer- and Internet-based surveys. Thus, Internet surveys assessing psychological health and well-being issues appear to be quite suitable for use with young people.

Compared with the response rates obtained from telephone or mail questionnaires, the number of responders per day may seem somewhat low. We received responses from 100,000 to 150,000 individuals per day, which represents approximately 36% of the entire population of members (1.2 million). Approximately 350,000 people logged in on

a given day, raising the possibility of selection bias. Because the subjects were anonymous, we could not investigate selection effects. However, a recent study using the Internet for health-related topics was independent of gender, age and diagnostic group in a group of patients with psychosomatic disorders (21). Although the design of that study was not entirely comparable with the present study, it is an indication of that there was limited selection bias in our study. Additionally, the response rate obtained at LunarStorm was very high for such a generalised Internet-based survey.

Conclusion

A relatively high percentage of young people, particularly females 16 to 18 years of age, had psychosomatic complaints that did not seem to improve between 2007 and 2010. A considerable worsening of these complaints occurred from the age of 12 years onwards in both sexes. Internet-based survey assessment appears a valuable tool for examining self-perceived health in young people over a broad range of ages. Thus, strong emphases must be placed on improving life conditions during early phases, such as in school environments, and then later on facilitating the transition into early adulthood.

Figure legends

Fig 1. Bars depict the percentage of “never” to “very often” responses to the question “How often/seldom do you feel stressed?” for 10- to 24-year-old females and males. The total number of respondents was 148 395. For the statistics, see the text.

Fig 2. Bars demonstrate the percentage of “never” and “very often” responses to the question “How often/seldom do you feel stressed?” divided by sex and age. The numbers in the graph represent the number of responding individuals. The statistics are reported in the text.

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Dear Mr. Richard Sands
Editor, BMJ Open February 29 2012

Thank you for the fast response of our manuscript. We are happy to receive important comments for revisions and, of course, glad to be able to resubmitting an improved version. Please see our detailed responses (changes to the paper and comments accordingly) below. Changes (new text in the manuscript) are presented in yellow and manuscript text is shown in italic, our comments in ordinary font and the reviewer´s questions are shown in bold.

We acknowledge the confusion, and apologise for our mixing the messages, as the main critique from both reviewers. Our first and most important goal was, and always will be, starting from the situation of the young, i.e. from the medical/health perspective. The Internet is just a tool (albeit a valuable one) that helps getting access to a large population, making a more true picture of the prevailing psychosomatic status among the young, In addition, we used validated questionnaires, which have substantial documentation (refs Hagquist, also co-author).

The manuscript has been read and corrected by professional manuscript editing company (American Journal Experts).

We believe that the present version is improved and we hope that our changes and comments will be to your satisfaction.

Sincerely

/Peter Friberg, professor
on behalf of the authors

Response to reviewer: Rafael Mikolajczyk,
Bremen Institute for Prevention Research and Social Medicine, Bremen, Germany

"The paper is unfocussed. Clearly some information is there, but technical deficiency of the description is obscuring this fact. The message is not clear because the research question is not clear."

Our research question(s) have now been more explicitly explained and defined both in the summary and introduction parts. The introduction has been rewritten. The summary now reads:

Summary
Article focus:

- *Examining self-perceived health and stress in large cohorts of children, adolescents, and young adults*
- *Examining whether psychosomatic health deteriorated in adolescents between 2007 and 2010.*
- *Using a large web-based community on the Internet to investigate self-perceived psychosomatic health in Swedish youth.*

Key messages

- *A high percentage of young subjects responded that they felt stressed very often/often, and the numbers were higher for females than for males.*
- *Older teenaged females had more psychosomatic complaints than males did.*
- *Both sexes reported a slightly worse self-perceived health status in 2010 than in 2007.*
- *Novel internet-based community site surveys are feasible for assessing self-perceived health in the young.*

Strengths and limitations

- *Very large cohort of both children, adolescents and young adults from the whole of Sweden*
- *All subjects responded completely voluntarily.*
- *There may be a selection bias, given that we do not know the psychosomatic health in subjects who are not logged onto the website.*
- *Participation in the survey was completely anonymous; thus, we could not perform additional interviews to study the web questions' validity in this population.*

The introduction now reads, also including new references:

....Importantly, the development of stress reactions in young people is, to a great extent, gender dependent (ref 4,5,6,7). Mid section 1st paragraph, page 4.

Given the recent development of higher frequencies of reported ill health in children, adolescents, and young adults, particularly older teenage girls, in Sweden and

internationally (8-13), the aim of this study was to obtain reliable information both at a given time point and as a trend analysis about perceived health in Swedish subjects aged 10 to 24 years. To achieve this purpose, we needed a strategy that would feasibly allow us to ascertain a large number of respondents. Donker et al. (14) used screening questionnaires for common mental disorders and recommended that such questionnaires be administered via the Internet, which offers quick and easy access to a large number of users at a low cost. The screening must be brief, as subjects are more likely to undergo screening if it is short, quickly completed, and easy to read (14).. 2nd paragraph, page 4, Vide infra.

"The paper surely addresses relevant research question and uses a relatively novel approach. Nevertheless, I have substantial concerns regarding the technical quality of the paper. The paper is unfocussed it is not clear if the main message are the results regarding self-perceived health or the description of methodology of the online survey (for example conclusions start with pointing out methodological aspects). It is not clear in which way the study supplements the results of previous studies. Further, it has to be justified why the data collection was conducted in the described way in the moment it seems to be more a game rather than a rigorous study of methodology for the online survey. "

We understand the confusion, and apologise for our mixing the messages. Our first and most important goal was and always will emanate from the situation of the young, i.e. from the medical/health perspective. The Internet is just a tool (albeit a valuable one) that helps in getting access to a large population, making a more true picture of the prevailing psychosomatic status among the young, In addition, we used validated questionnaires, which have substantial documentation (refs Hagqvist, also co-author).

Thus our main and first message is the description of psychosomatic symptoms among the young with a wide range of age in Sweden, and over time. The second, and subordinate message is to demonstrate the feasibility of a web-based self-assessment questionnaire presented to members of a "social" community. In order to increase clarity, this sequence of message importance is now followed consequently through the paper.
As the data collection method has its specific strengths and limitations we are convinced that in order to understand the presentation of the data on psychosomatic symptoms, the reader needs to know how the data collection was performed.

The parts: "introduction, research questions and conclusion", now have a structure starting with the psychosomatic symptom issues in the young, and are followed by text regarding the web based community survey method. Hopefully, the readers will get the main message by this rearrangement.

Further, we have added more data and discussion to the "introduction and discussion" parts of previous studies and added some valuable references, which are put in context with the present study. A more thorough description of the rationale for the methodology for the online survey has now been included:

....Importantly, the development of stress reactions in young people is, to a great extent, gender dependent (ref 4,5,6,7), page 4, 1st paragraph*). Hence, it seems*

plausible that several factors, both psychological and physical, play important roles in children's well-being and ill health, with salient implications for future health and disease (new ref 7), page 4 end 1st paragraph).

… Donker et al. (14) used screening questionnaires for common mental disorders and recommended that such questionnaires be administered via the Internet, which offers quick and easy access to a large number of users at a low cost. The screening must be brief, as subjects are more likely to undergo screening if it is short, quickly completed, and easy to read (14). Page 4, end 2nd paragraph.

….. The scoring procedure has been psychometrically analysed using the Rasch model (15), which is based on the same questionnaire that was used in the current study. The outcomes from the Rasch analysis of the PSP scale have been reported in a previous paper (16). The analysis confirmed the appropriateness of considering somatic and psychological problems as interacting parts that constitute a higher-order, unidimensional construct (psychosomatic health). The scale showed valid psychometric properties and met the measurement requirements of invariance and proper item categorisation. Page 6, end 2nd paragraph.

According to the reviewer´s pointing out the lack of specific focus, we have, accordingly, rewritten the first paragraph of the "discussion", which now reads (page 11):

We found marked differences between the sexes regarding psychosomatic symptoms, with females reporting higher degrees of stress compared with males across the large age span between 10 and 24 years of age. These symptoms appeared to be most pronounced between 16 and 18 years of age and then declined, supporting and extending the results of Hagquist (4). Similar findings using the same eight questionnaire items were reported previously (4,10); however, these findings came from smaller regional studies that administered the questionnaires in person (by distributing them in schools). The present study used the Internet to assess psychosomatic health in young people using well-established questions (4,10,11), with the beneficial result of having a high number of respondents in each age and sex category. Another advantage was that each subject could log into her or his own "LunarStorm corner" and voluntarily choose to complete the questions on the community site, which would make the subjects more likely to provide honest answers.

Further added references and comments upon earlier studies (discussion, page 13, top):

Self-perceived health was undoubtedly worse for females than for males, irrespective of age; this finding is supported by earlier studies (5,6) and the results of Osika et al. (12), who used Beck Youth Inventory questionnaires.

Further added changes under the subheading "methodological considerations and limitations":

There are few data available regarding Internet-based surveys of psychological health among young people; thus, there are few validation analyses. Donker et al. (14)

validated a brief web-based screening questionnaire for common mental disorders with follow-up phone interviews, using a "gold standard' interview guide to assess the presence of DSM-IV disorders in the previous 6 months. Their questionnaire screened for common mental disorders. However, the subjects in the present study could not be identified; thus, such a validation was not possible. (page 14, 2nd paragraph).

Approximately 350,000 people logged in on a given day, raising the possibility of selection bias. Because the subjects were anonymous, we could not investigate selection effects. However, a recent study using the Internet for health-related topics was independent of gender, age and diagnostic group in a group of patients with psychosomatic disorders (21). Although the design of that study was not entirely comparable with the present study, it is an indication of that there was limited selection bias in our study. Additionally, the response rate obtained at LunarStorm was very high for such a generalized Internet-based survey. (page 15).

Additional changes made to the paragraph under the subheading "conclusion"

A relatively high percentage of young people, particularly females 16–18 years of age, had psychosomatic complaints that did not seem to improve from 2007 to 2010. A considerable worsening of these complaints occurred from the age of 12 years and onward in both sexes. Internet-based survey assessment appears a valuable tool for examining self-perceived health in young people over a broad range of ages.
Thus, strong emphasis must be placed on improving life conditions during early phases, such as in school environments, and then later on facilitating the transition into early adulthood. (page 15, bottom).

"Many aspects are not well expressed and there are linguistic errors making a substantial rewriting and editing necessary."

The text has been re-edited and rewritten both in introduction, methods and discussion, and the linguistic errors have been corrected by a professional editing company.

Reviewer: Mari Hysing
Unihealth, Bergen , Norway

I have no competing interest.

"The development of self-perceived psychosomatic health is an important subject, likewise the use of internet based assessment in assessing this."

We thank you for acknowledging the importance of the subject studied

"However, the focus of the paper is somewhat unclear and a more focused approach could improve the manuscript. Either focusing on internet assessment, and write the introduction and run statistical analysis to

answer research question or focus (is the group representative?, are the psychometric properties of the instruments comparable to other paper-pen studies and so on, other studies using internet assessment and discussing pro and cons of this alternative). Or discussing age and gender related psychosomatic concerns more specifically. The introduction could then cover more of this literature and previous findings and more appropriate analysis. One of the research questions is if psychosomatic health improves over time. However, the results focus more on gender effects, and do not appropriately control for confounders when assessing time-effects. If gender effects are the main focus, the results should be discusses in relation to previous literature."

Clearly, our main goal and message is the description of psychosomatic symptoms among a large range of ages of youth in Sweden, and over time, and the second message is showing the feasibility of using web based self-assessment questionnaires in a large community as a valuable tool. In order to increase clarity, this sequence of message importance now is followed through the paper. Please see also the responses above, given the similar questions from both reviewers.

We have tried to refine the description of age and gender related psychosomatic concerns more specifically.

Summary

Article focus:

- *Examining self-perceived health and stress in large cohorts of children, adolescents, and young adults on a completely voluntary basis*
- *Examining whether psychosomatic health deteriorated in adolescents between 2007 and 2010.*
- *Using a large web-based community on the Internet to investigate self-perceived psychosomatic health in Swedish youth.*

Key messages

- *A high percentage of young subjects responded that they felt stressed very often/often, and the numbers were higher for females than for males.*
- *Older teenaged females had more psychosomatic complaints than males did.*
- *Both sexes reported a slightly worse self-perceived health status in 2010 than in 2007.*
- *Novel internet-based community site surveys are feasible for assessing self-perceived health in the young.*

Strengths and limitations

- *The study examined a very large cohort of children, adolescents and young adults from throughout Sweden.*
- *All subjects responded completely voluntarily.*
- *There may be a selection bias, given that we do not know the psychosomatic health of individuals who were not logged onto the website.*
- *Participation in the survey was completely anonymous; thus, we could not perform additional interviews to study the web questions' validity in this population.*

The introduction now reads, also including new references:

....Importantly, the development of stress reactions in young people is, to a great extent, gender dependent (ref 4,5,6,7), page 4, 1st paragraph*). Hence, it seems plausible that several factors, both psychological and physical, play important roles in children's well-being and ill health, with salient implications for future health and disease (new ref 7), page 4 end 1st paragraph).*

….. The scoring procedure has been psychometrically analysed using the Rasch model (15), which is based on the same questionnaire that was used in the current study. The outcomes from the Rasch analysis of the PSP scale have been reported in a previous paper (16). The analysis confirmed the appropriateness of considering somatic and psychological problems as interacting parts that constitute a higher-order, unidimensional construct (psychosomatic health). The scale showed valid psychometric properties and met the measurement requirements of invariance and proper item categorisation. Page 6, end 2nd paragraph.

We have now added more literature references covering gender differences in psychological and psychosomatic complaints. Controlling for confounders in this study is hard, since the participants are anonymous and we don't have data on any possible confounders. Therefore, we believe that the meticulous description of the data collection strategy is of pivotal importance.

Self-perceived health was undoubtedly worse for females than for males, irrespective of age; this finding is supported by earlier studies (5,6) and the results of Osika et al. (12), who used Beck Youth Inventory questionnaires.

Further added changes under the subheading "methodological considerations and limitations":

There are few data available regarding Internet-based surveys of psychological health among young people; thus, there are few validation analyses. Donker et al. (14) validated a brief web-based screening questionnaire for common mental disorders with follow-up phone interviews, using a "gold standard' interview guide to assess the presence of DSM-IV disorders in the previous 6 months. Their questionnaire screened for common mental disorders. However, the subjects in the present study could not be identified; thus, such a validation was not possible. (page 14, 2nd paragraph).

Approximately 350,000 people logged in on a given day, raising the possibility of selection bias. Because the subjects were anonymous, we could not investigate selection effects. However, a recent study using the Internet for health-related topics was independent of gender, age and diagnostic group in a group of patients with psychosomatic disorders (21). Although the design of that study was not entirely comparable with the present study, it is an indication of that there was limited selection bias in our study. Additionally, the response rate obtained at LunarStorm was very high for such a generalized Internet-based survey. (page 15).

Additional changes made to the paragraph under the subheading "conclusion"

A relatively high percentage of young people, particularly females 16–18 years of age, had psychosomatic complaints that did not seem to improve from 2007 to 2010. A considerable worsening of these complaints occurred from the age of 12 years and onward in both sexes. Internet-based survey assessment appears a valuable tool for examining self-perceived health in young people over a broad range of ages.
Thus, strong emphasis should be placed on improving life conditions during early phases, such as in school environments, and later on facilitating the transition into early adulthood. (page 15, bottom).

"The tables would communicate better if they highlight the most important findings. Sumvariables instead of showing percentages for all responses is one possibility."

We have considered both ways, and we arrived at the conclusion that percentage values seem more simply to adhere to. We have also asked some other researchers and they are of the same opinion, i.e. that percentage presentation is meaningful and that sumvariables do not increase the "presented value". Hence we keep the percentage numbers.

Highlighting the main finding, and running more regression analysis and less descriptive data could also improve the readability and communicate your findings better.

In the first place, we would be better off, have we had access to basic raw data. This was not unfortunately the case. Hagqvist has pointed out previously that the 8-item questions relate to each other. Our main foci are 3-fold (for which you do not need regression analysis): i) showing stress and psychosomatic symptoms across a wide range of ages (10-24y), ii) gender aspects and iii) comparing psychosomatic symptoms between 2005, 2007 and 2010.
In coming studies, we are most certainly keen to make regression analyses between various items; your point is definitely worth considering then.

Self-perceived psychosomatic health in Swedish children, adolescents, and young adults: An Internet-based survey over time

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Self-perceived psychosomatic health in Swedish children, adolescents, and young adults: An Internet-based survey over time

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Running title: Stress in youth examined via the Internet

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Summary

Article focus:

- Examining self-perceived health and stress in large cohorts of children, adolescents, and young adults who are members of a large, Swedish web-based community.
- Examining whether psychosomatic health deteriorated in adolescents between 2007 and 2010.
- Assessment of the usability of a large web-based community on the Internet to investigate self-perceived psychosomatic health in Swedish youth.

Key messages

- A high percentage of young subjects responded that they felt stressed very often/often, and the numbers were higher for females than for males.
- Older teenaged females had more psychosomatic complaints than males did.
- Both sexes reported a slightly worse self-perceived health status in 2010 than in 2007.
- Novel internet-based community site surveys are feasible for assessing self-perceived health in the young.

Strengths and limitations

- The study examined a very large cohort of children, adolescents and young adults from throughout Sweden.
- All subjects responded completely voluntarily.
- There may be a selection bias, given that we do not know the psychosomatic health of individuals who were not logged onto the website.
- Participation in the survey was completely anonymous; thus, we could not perform additional interviews to study the web questions' validity in this population.

Abstract

Objectives: We investigated self-perceived psychosomatic health in young people (10 to 24 years of age) in Sweden and analysed different samples during the years 2005, 2007 to 2010 via a community website.

Design: Repeated cross-sectional surveys: (i) a single question on a single day 2005. (ii) One specific question delivered on each of eight separate days 2005. (iii) The same eight questions, delivered to a smaller group of randomly selected 15- to 20-year-olds on the same day in 2007 and then again to a new age-matched group of randomly selected subjects in 2010. Validated questionnaires were launched on the Internet by a recognised Swedish community site. Eligible study participants were invited to answer questions about their health with full anonymity as they logged in to their personal area on the website.

Results: A large number of responses were obtained, from approximately 750 to 1 600 for the 2007 and 2010 questionnaires, to around 130 000 when questions were asked separately in 2005. A high percentage of young subjects responded that they felt stressed very often/often; the numbers were higher for females (47%) than for males (29%). Older teenaged females had more psychosomatic complaints than did males of similar ages; in contrast, among 10- to 12-year-old children, the percentage of psychosomatic complaints was similar for males and females. When comparing results obtained in 2010 with those obtained in 2007, young people of both sexes had a slightly better self-perceived health status in 2007.

Conclusions: During the period 2005 to 2010 a high percentage of young people, particularly females 16 to 18 years of age, had psychosomatic complaints, and considered themselves as being often or very often stressed. These complaints were more pronounced in the older age groups. When directing questions to a large community, Internet-based surveys appear to be valuable tools.

Keywords: Self-perceived health, psychosomatic, children, adolescents

Introduction

Children's life situations have changed dramatically over the past decades. Several conditions in today's modern information-based society have exposed children to seemingly increased levels of stress in multiple ways [1-2]. Lupien et al. noted that risk factors for the development of stress reactions depend primarily on an individual's genetic vulnerability, exposure to adverse life events, socioeconomic situation, disturbances in important relationships, problems with school, and the timing of stressful events (3). Importantly, the development of stress reactions in young people is, to a great extent, gender-dependent (4,5,6). Thus, it seems plausible that several factors, both psychological and physical, play important roles in the development of stress reactions which will have an impact on children's well-being and ill health, with salient implications for future health and disease (7).

High frequencies of ill health such as complaints about perceived stress, and psychosomatic symptoms in children, adolescents, and young adults, particularly older teenage girls, have recently been reported in Sweden and internationally (8-13). The aim of this study was to obtain information both at a given time point and as a analysis at different time points about perceived stress and psychosomatic symptoms in Swedish subjects aged 10 to 24 years. To achieve this purpose, we needed a strategy that would feasibly allow us to ascertain a large number of respondents. Donker et al. (14) used screening questionnaires for common mental disorders and recommended that such questionnaires be administered via the Internet, which offers quick and easy access to a large number of users at a low cost. The screening must be brief, as subjects are more likely to undergo screening if it is short, quickly completed, and easy to read (14).

Our primary and main aim was to explore psychosomatic health problems among children and adolescents, focusing on sex and age differences, using a web-based protocol launched on a large internet community.

To our knowledge, this study is the first to use the Internet to examine self-perceived health and stress in large cohorts of children, adolescents, and young adults. Furthermore, as a secondary objective we explored possible changes in the percentages of self-reported health complaints over a three-year period from 2007 to 2010.

Methods

The present study used the Internet to assess psychosomatic health in young people using well-established questions (4,10,11), with the beneficial result of having a high number of respondents in each age and sex category. Each subject could log into her or his own "LunarStorm corner" and voluntarily choose to complete the questions on the community site, which would make the subjects more likely to provide honest answers. Compared with the response rates obtained from telephone or mail questionnaires, the number of responders per day may seem somewhat low. We received responses from 100,000 to 150,000 individuals per day, which represents approximately 36% of the entire population of members (1.2 million).

Data were collected via Internet-based questionnaires consisting of three parts: (i) a single question about "stress," launched on the Internet on a single day in January 2005. (ii) Eight questions about subjective health that were completed between 26 May and 28 June 2005. One question was delivered on each of eight separate days. (iii) The same eight questions (comprising a composite measure of subjective health),

delivered to smaller groups of randomly selected 15- to 20-year-olds on the same day in May 2007 and then again to a new age-matched group of randomly selected adolescents and young adults in May 2010. The subjects had complete freedom regarding whether to complete or abstain the questionnaire.

Apart from the single question about stress, the aforementioned eight questions were developed and tested for reliability and used by the Swedish National Board of Health and Welfare (www.socialstyrelsen.se) in studies of the psychological health and well-being of children and adolescents. The composite measure of subjective health (4) is comprised of the following items: difficulty concentrating, difficulty sleeping, suffers from headaches, suffers from stomach-aches, feels tense, poor appetite, feels low, and feels dizzy. The response categories for all of these items, which were delivered in question form, were “don’t know”; “no, never”; “no, seldom”; “yes, sometimes”; “yes, often”; and “yes, always”. The outcomes from psychometric Rasch analysis of the PSP scale have been reported in previous papers (15, 16). The analysis confirmed the appropriateness of considering somatic and psychological problems as interacting parts that constitute a higher-order, unidimensional construct (psychosomatic health). The scale showed valid psychometric properties and met the measurement requirements of invariance and proper item categorisation. The Rasch model further revealed that from a general level of analysis, the eight items were invariant among students with good health and among those with bad health. Importantly, these eight questions also work invariantly across time; i.e., there is no differential item functioning with respect to the year of investigation, which is a prerequisite for repeated analysis, as in the present study.

The item about stress was “How often/seldom do you feel stressed?”, and the response categories were “yes, very often”; “yes, often”; “yes, sometimes”; “no, seldom”; “no, very seldom”; “no, never”; and “don’t know”.

Initially, we placed one question per day on LunarStorm’s website, which was one of the first web communities to be established in Sweden. At the time of our investigations in 2005 and 2007, LunarStorm was the largest Internet community in Sweden. It had 1.3 million active members and approximately 360,000 unique visitors per day who spent approximately 40 minutes per visit on the site (TNS Gallup/Red Measure, Nielsen/Net Ratings). Eighty-three per cent of 15- to 20-year-olds in Sweden were LunarStorm members, and 25 out of 30 pupils in every secondary school class were members (Lunarworks AB/SCB). The gender distribution of members was 53% females.

Members saw the question after log-in, and only one answer per log-in was allowed and counted. We focused on children, adolescents, and young adults from 10 to 24 years old. The percentage of LunarStorm members in each age class in Sweden ranged from 20% to 88%, with the highest values (>80%) for adolescents between 13 and 16 years of age (Statistics Sweden, www.scb.se). The reason why we placed one question per day instead of presenting the whole eight item questionnaires at one single occasion was that the web community administrator had the experience that using such long composite questionnaires decreased the participation rate substantially. However, after receiving high response rates on the separate items we decided to include the whole eight item questionnaire at one specific time point.

The first set of eight questions was released on the Internet on a single day in 2007 to a group of 15- to 20-year-old subjects who were randomly selected by the community websites using statistical methods. Children and younger adolescents were not included, as they were in the protocol that presented one question per day. We chose to focus on 15- to 20-year-olds because of their higher response rate. Because questions released on separate days would attract a very large number of responders, we were able to divide the subjects not only into gender groups but also into various age groups (Table 1). In yet another Internet-based protocol using the same eight questions described above to determine self-perceived health trends, the subjects were randomly selected in both May 2007 and in May 2010 to respond to the questions. These groups comprised approximately 1,500 subjects aged 15 to 20 years (Table 2).

Ethical approval was obtained from the chairman of the review board. According to the ethical guidelines, posting questionnaires on the Internet does not require ethical approval from a committee. However, we choose to discuss these issues thoroughly with the chairman and received full approval.

Statistical analyses

The Mann-Whitney U test and the Kruskal-Wallis and chi-squared tests were used. Each of the possible responses to each of the eight questions in the Likert format was assigned a number (“no, never=1”; “no, seldom=2”; “yes, sometimes=3”; “yes, often=4”; and “yes, always=5”), which was multiplied by the response frequency and then averaged. The same procedure was performed with the item about stress and the response categories were “yes, very often=6”; “yes, often=5”; “yes, sometimes=4”; “no,

seldom=3"; "no, very seldom=2"; "no, never=1"; the answer "don't know" was not included in the statistical calculations. Statistical significance was considered when $p < 0.05$.

Results

Consistently more girls answered the questions, and there was an age-group related decline in the severity of self-perceived health; however, girls still reported higher frequencies of psychological ill-health during the whole investigated age-span. The peak of problems experienced occurred in adolescents aged 16 to 18 years, and females perceived the most problems.

Item about stress

The single question about stress received 148,395 responses (85,330 girls) from 10- to 24-year-olds. The vast majority of this population was between 10 and 24 years old. When analysing the total population, we found that 30% of the females and 19% of the males considered themselves stressed very often (Figure 1). Similarly, the response "yes, often" was provided more often by females: 17% vs. 10% in males ($p < 0.0001$). When the 10- to 24-year-old population was divided into age subgroups, we found that 16- to 18-year-old males and females reported the highest degree of stress (very often): 22% for males and 37% for females (Figure 2, $p < 0.0001$). The lowest number of subjects responding "yes, often" to stress was in the 10- to 12-year-old group. Consistently, females were significantly more likely to report higher levels of stress ("very often" and "often") than males from 10 to 24 years of age. The percentage of males responding "yes, very often" to the stress question remained relatively constant at 20% from 13 to 24 years of age, while the percentage of females responding "yes,

very often" increased until they reached 16 to 18 years old and levelled off for those who were 19 to 24 years old. However, this older female group still showed statistically significantly higher values for self-perceived stress than males of the same age (Figure 2). Males of all ages chose the alternative response "no, never" to the question about stress statistically more frequently than females (Figure 2).

Eight questions presented via the Internet on separate days to 10- to 24-year-olds (Table 1)

Given that these questions were placed one at a time, the response frequency varied between 12,000 and 45,000 subjects, who were mainly in the 10- to 12-year-old and 13- to 18-year-old age groups, respectively; the response frequencies for all eight questions were similar. When all of the possible responses to all eight questions were considered, we found that males of all age groups scored higher in terms of self-perceived health compared with females ($p < 0.0001$). The only exceptions in which there were no differences between males and females occurred in the 10- to 12-year-old group regarding difficulty concentrating ($p = 0.11$) and in the 19- to 24-year-old group regarding difficulty sleeping ($p = 0.16$).

An analysis of the four age groups' responses to all of the questions (except for the question regarding poor appetite) revealed that the older the subjects, the poorer their self-perceived health ($p < 0.0001$). Both females and males demonstrated poorer self-perceived health the older they were ($p < 0.0001$ for both, except for $p = 0.04$ for poor appetite in females). However, males reported fewer headaches ($p = 0.02$) and better appetite ($p = 0.003$) with increasing age. When we adjusted for the differences in sex, we found poorer self-perceived health with increasing age ($p < 0.0001$), with the exception of poor appetite ($p = 0.52$), which received opposite overall responses for

males and females, as described above. Similarly, when we adjusted for differences in age, we found better self-perceived health in males than in females ($p < 0.0001$).

Eight questions regarding self-perceived health presented together on the Internet in 2007 and 2010

Males reported better self-perceived health than females for all eight questions in the 2007 questionnaire (Figure 3, $p < 0.0001$). The results were similar in 2010, with males reporting better self-perceived health than females regarding headache, stomach-ache, feeling tense, poor appetite, feeling low, and feeling dizzy (Figure 3, $p < 0.0001$) as well as difficulty sleeping ($p = 0.002$). The difference between males and female regarding difficulty concentrating was not statistically significant ($p = 0.06$). There were subtle differences between the overall responses to the 2007 and 2010 questionnaires. Males demonstrated better self-perceived health in 2007 vs. 2010 regarding feeling low, poor appetite, feeling tense, and difficulty sleeping and concentrating (Table 2). Females presented a similar pattern of better self-perceived health, with the exception of poor appetite (no change). The items stomach-ache, headache, and feeling dizzy remained unchanged from 2007 to 2010 for both sexes (Table 2).

Discussion

We found marked differences between the sexes regarding psychosomatic symptoms, with females reporting higher degrees of stress compared with males across the large age span between 10 and 24 years of age. These symptoms appeared to be most pronounced between 16 and 18 years of age and then declined, supporting and extending the results of Hagquist (4). Similar findings using the same eight questionnaire items were reported previously (4,10); however, these findings came from smaller regional studies that administered the questionnaires in person

(by distributing them in schools). The present study used the Internet to assess psychosomatic health in young people using well-established questions (4,10,11), with a high number of respondents in each age and sex category. The fact that each subject could voluntarily and anonymously choose to complete the questions on the community site, could have made the subjects more prone to provide honest answers.

As shown in the present study and what has been noted previously (4,11), is that females are more likely than males in the same age group to report feeling stressed across both childhood, adolescence and as young adults. Notably, while females seem to increase their reporting of stress and psychosomatic symptoms from childhood to young adults, similar variables are remarkably constant from 13 to 24 years of age in males. These salient sex differences may be explained by the fact that there are real differences in stress levels and psychosomatic symptoms between the sexes, or that girls are more self-aware and reflecting and therefore more able to assess their psychological health, or that it is more culturally acceptable for girls to report psychosomatic symptoms, or a combination of the factors above. Boys might be more inclined to express themselves more physically, like being more active in sports, or pursue other forms of acting out behaviour (10).

For several, but not all, of the questions, self-perceived health was better in 2007 than in 2010 for both males and females perhaps reflecting the financial crisis that emerged in 2008. Although the changes between 2007 and 2010 were quite small, and the time elapsed was perhaps too short, we did note similar differences between males' and females' responses in 2005, 2007, and 2010. Self-perceived health was undoubtedly worse for females than for males, irrespective of age; this finding is supported by

earlier studies (5,6) and the results of Osika et al. (12), who used Beck Youth Inventory questionnaires.

Our data, together with the results of previous studies (4,8,12,13,17), point unequivocally to impaired self-reported psychological and psychosomatic health in the young, and the prevailing situation and trend do not seem to be improving. The psychosomatic health of young females is of particular concern, given the increase in complaints that appears to have occurred over the past 20 years, as indicated by surveys in Sweden (4). However, the figures regarding alcohol problems, criminality, and suicide are much higher for males than for females in the 16- to 24-year-old group (10).

Given that the majority of the subjects in the present study was school-aged, the school environment is an important factor to consider. Previous reports established links between the school environment and the psychological and psychosomatic symptoms of schoolchildren (9,18). In fact, Hjern et al. (13) demonstrated an association between school stressors, such as harassment by peers, schoolwork pressure, and being treated poorly by teachers, as well as psychosomatic pain and psychological problems, reflected as sadness, irritability, and feeling unsafe and nervous. In the light of our demonstrated sex differences also during school-age, one may surmise that factors related to school environment might affect girls and boys differently.

Methodological considerations and limitations

The eight-item scale we used was validated in several studies as an appropriate means of estimating the subjective health complaints of children and adolescents. The instrument was also examined with the Rasch model, for which invariance is essential (16,19). There are few data available regarding Internet-based surveys of psychological health among young people; thus, there are few validation analyses. Donker et al. (14) validated a brief web-based screening questionnaire for common mental disorders with follow-up phone interviews, using a "gold standard' interview guide to assess the presence of DSM-IV disorders in the previous 6 months. Their questionnaire screened for common mental disorders. However, the subjects in the present study could not be identified; thus, such a validation was not possible.

A study by Mangunkusumu et al. (20) demonstrated good agreement between responses to questionnaires that were handed out manually and those administered via the Internet. Notably, the Internet approach received more favourable evaluations, even though it also took place in a school milieu. A major advantage of the present study was that the subjects could choose whether to answer the questions while in a familiar private and comfortable environment. Furthermore, such administrative factors as data transcription, the risk of excluded values and "odd" answers, and the concern that other people might read the answers can be overcome by computer- and Internet-based surveys. Thus, Internet surveys assessing psychological health and well-being issues appear to be quite suitable for use with young people.

Approximately 350,000 people logged in on a given day, raising the possibility of selection bias. Because the subjects were anonymous, we could not investigate selection effects. However, a recent study using the Internet for health-related topics was independent of gender, age and diagnostic group in a group of patients with

psychosomatic disorders (21). Although the design of that study was not entirely comparable with the present study, it is an indication of that there was limited selection bias in our study. Additionally, the response rate obtained at LunarStorm was very high for such a generalised Internet-based survey.

Conclusion

A relatively high percentage of young people, particularly females 16 to 18 years of age, had psychosomatic complaints that did not seem to improve between 2007 and 2010. A considerable worsening of these complaints occurred from the age of 12 years onwards in both sexes. Internet-based survey assessment appears a valuable tool for examining self-perceived health in young people over a broad range of ages.

Figure legends

Fig 1. Bars depict the percentage of “never” to “very often” responses to the question “How often/seldom do you feel stressed?” for 10- to 24-year-old females and males. The total number of respondents was 148 395. For the statistics, see the text.

Fig 2. Bars demonstrate the percentage of “never” and “very often” responses to the question “How often/seldom do you feel stressed?” divided by sex and age. The numbers in the graph represent the number of responding individuals. The statistics are reported in the text.

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TABLE 1

Proportion responders in % of 8 questions assessing self-perceived health asked on the web in May 2005. The column "don´t know" is not included in the subsequent calculations

Question/alternative	Yes, always	Yes, often	Yes, some-times	No, seldom	No, never	don´t know	Number of responders	Sex, %
Difficulty in concentrating								
10-12 years old								
-females	7	8	40	17	11	17	7526	63,4
-males	12	7	34	17	16	15	4341	36,6
13-15 years old								
-females	14	17	45	11	5	8	28889	62,2
-males	16	12	40	13	9	9	17544	37,8
16-18 years old								
-females	17	25	45	7	2	4	23846	56,0
-males	19	15	41	12	7	6	18756	44,0
19-24 years old								
-females	12	24	47	9	3	5	15114	53,2
-males	14	14	44	15	7	7	13318	46,8
Difficulty in sleeping								
10-12 years old								
-females	8	7	38	25	14	8	8229	63,8
-males	10	5	31	25	22	7	4673	36,2
13-15 years old								
-females	11	10	41	24	10	5	29133	62,4
-males	13	6	31	27	18	5	17546	37,6
16-18 years old								
-females	12	13	45	20	7	2	23525	56,8
-males	15	8	34	23	16	3	17923	43,2
19-24 years old								
-females	11	16	46	19	6	1	15430	54,3
-males	14	12	39	21	12	2	13007	45,7
Suffering from headache								
10-12 years old								
-females	9	12	40	22	9	8	8867	64,8
-males	11	8	34	23	15	9	4825	35,2
13-15 years old								
-females	13	16	42	20	6	4	27817	62,5
-males	13	8	35	26	12	5	16657	37,5
16-18 years old								
-females	13	19	45	17	4	2	19145	56,1
-males	12	7	37	28	12	4	14984	43,9
19-24 years old								
-females	9	22	48	17	3	1	12368	53,5
-males	9	8	39	30	11	3	10737	46,5
Suffering from stomach pain								
10-12 years old								
-females	7	9	35	22	12	15	7978	64,7
-males	9	5	24	23	22	17	4351	35,3
13-15 years old								
-females	9	13	42	20	8	8	27147	63,6
-males	12	5	26	24	21	11	15546	36,4
16-18 years old								
-females	10	17	45	18	6	4	19364	56,6
-males	11	5	28	26	21	9	14836	43,4
19-24 years old								
-females	10	20	47	16	4	3	12836	54,0
-males	8	7	32	27	18	8	10926	46,0

Table 1 cont´d

Question/alternative	Yes, always	Yes, often	Yes, sometimes	No, seldom	No, never	don´t know	Number of responders	Sex, %
Feeling tense								
10-12 years old								
-females	6	7	32	21	11	23	7477	61,2
-males	10	4	28	20	18	19	4749	38,8
13-15 years old								
-females	9	14	38	16	6	16	25342	59,6
-males	14	6	32	18	15	14	17195	40,4
16-18 years old								
-females	13	24	40	11	4	9	18230	53,4
-males	15	9	38	16	13	9	15888	46,6
19-24 years old								
-females	14	25	46	7	3	5	13056	53,9
-males	14	13	43	14	8	7	11170	46,1
Poor appetite								
10-12 years old								
-females	7	6	30	21	17	19	7887	63,9
-males	9	4	23	21	25	18	4457	36,1
13-15 years old								
-females	8	8	36	21	16	11	26356	62,5
-males	11	4	23	22	29	12	15786	37,5
16-18 years old								
-females	7	9	41	21	16	6	17385	55,1
-males	10	4	26	21	31	8	14168	44,9
19-24 years old								
-females	5	9	42	22	18	4	10611	52,7
-males	7	5	30	22	30	6	9527	47,3
Feeling low								
10-12 years old								
-females	9	15	45	16	6	8	9458	65,5
-males	10	7	33	23	16	11	4978	34,5
13-15 years old								
-females	13	24	44	11	4	4	31107	63,6
-males	12	8	35	23	15	8	17793	36,4
16-18 years old								
-females	12	30	47	8	2	2	23174	58,0
-males	11	11	41	20	11	16	16799	42,0
19-24 years old								
-females	9	30	51	8	1	1	15731	55,4
-males	9	14	47	19	7	5	12665	44,6
Feeling dizzy								
10-12 years old								
-females	6	8	41	23	10	13	7372	64,2
-males	10	6	34	23	16	11	4101	35,8
13-15 years old								
-females	9	13	46	18	6	8	24737	62,1
-males	14	7	36	22	12	8	15106	37,9
16-18 years old								
-females	8	16	51	16	4	5	18125	56,1
-males	13	8	40	21	11	7	14189	43,9
19-24 years old								
-females	5	15	54	16	5	5	12704	54,5
-males	10	8	44	21	10	7	10592	45,5

TABLE 2

Adolescents and young adults, aged 15 - 20 years responding to the same questions about self perceived psycho-somatic health (SPH) at two occasions, 2007 and 2010, respectively.

Question/alternative	Females change in SPH 2007 vs 2010, p and interpretation	Number of female responders 2007 and 2010	Males change in SPH 2007 vs 2010, p and inter pretation	Number of male responders 2007 and 2010
Difficulty in concentrating	0.04, better 2007	854, 1634	0.001, better 2007	808, 387
Difficulty in sleeping	0.004, better 2007	858, 1637	0.008, better 2007	818, 390
Suffered from headache	0.27, no difference	860, 1637	0.23, no difference	815, 388
Suffered from stomach ache	0.82, no difference	843, 1622	0.27, no difference	779, 380
Feeling tense	<0.0001, better 2007	837, 1599	<0.0001, better 2007	788, 382
Poor appetite	0.30, no difference	851, 1623	<0.0001, better 2007	797, 389
Feeling low	0.001, better 2007	864, 1635	0.0002, better 2007	804, 387
Feeling dizzy	0.29, no difference	838, 1618	0.16, no difference	793, 380

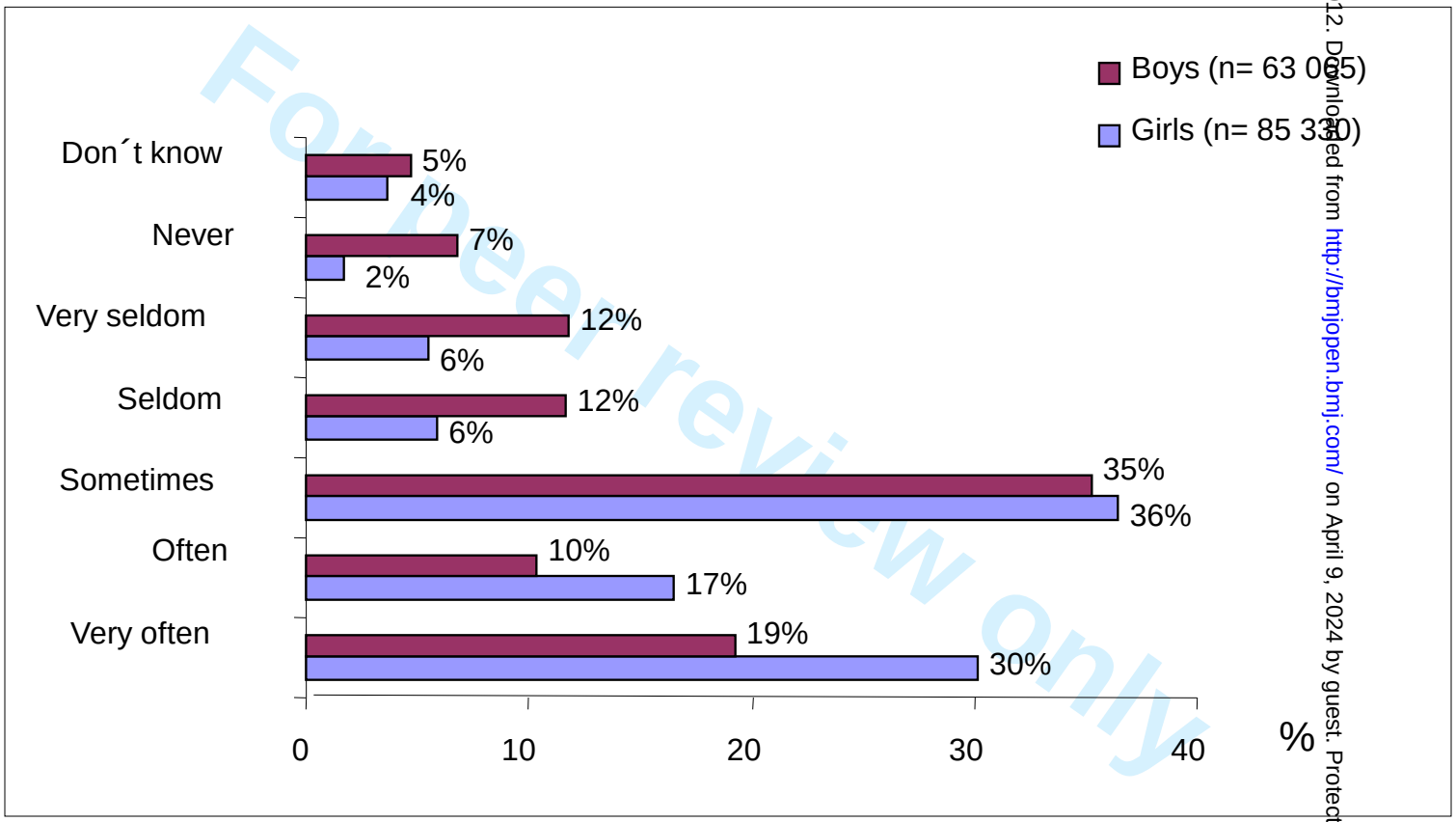
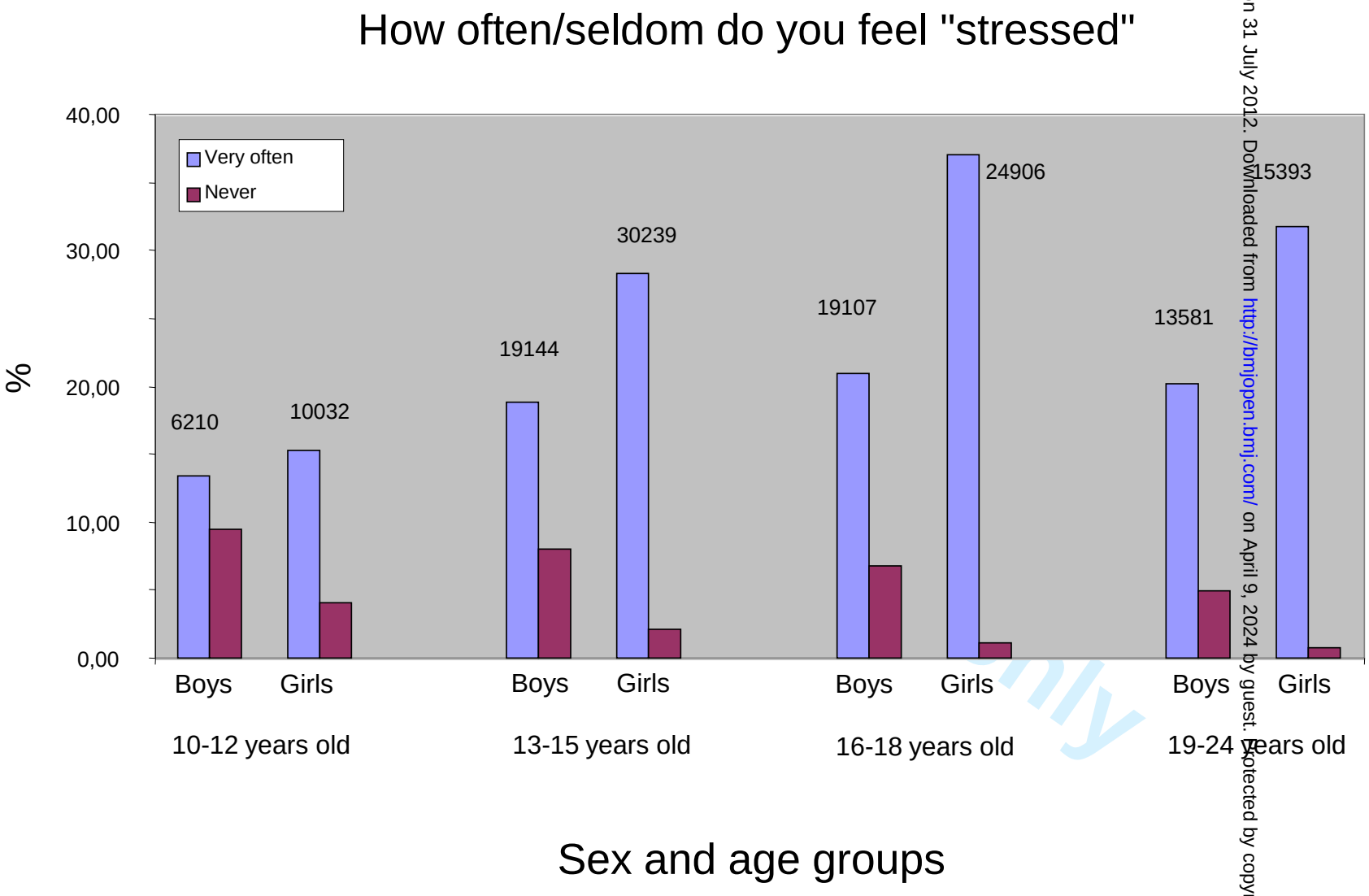


Fig 2



Self-perceived psychosomatic health in Swedish children, adolescents, and young adults: An Internet-based survey over time

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Running title: Stress in youth examined via the Internet

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Summary

Article focus:

- Examining self-perceived health and stress in large cohorts of children, adolescents, and young adults who are members of a large, Swedish web-based community.
- Examining whether psychosomatic health deteriorated in adolescents between 2007 and 2010.
- Assessment of the usability of a large web-based community on the Internet to investigate self-perceived psychosomatic health in Swedish youth.

Key messages

- A high percentage of young subjects responded that they felt stressed very often/often, and the numbers were higher for females than for males.
- Older teenaged females had more psychosomatic complaints than males did.
- Both sexes reported a slightly worse self-perceived health status in 2010 than in 2007.
- Novel internet-based community site surveys are feasible for assessing self-perceived health in the young.

Strengths and limitations

- The study examined a very large cohort of children, adolescents and young adults from throughout Sweden.
- All subjects responded completely voluntarily.
- There may be a selection bias, given that we do not know the psychosomatic health of individuals who were not logged onto the website.
- Participation in the survey was completely anonymous; thus, we could not perform additional interviews to study the web questions' validity in this population.

Abstract

Objectives: We investigated self-perceived psychosomatic health in young people (10 to 24 years of age) in Sweden and analysed different samples during the years 2005, 2007 to 2010 via a community website.

Design: Repeated cross-sectional surveys: (i) a single question on a single day 2005. (ii) One specific question delivered on each of eight separate days 2005. (iii) The same eight questions, delivered to a smaller group of randomly selected 15- to 20-year-olds on the same day in 2007 and then again to a new age-matched group of randomly selected subjects in 2010. Validated questionnaires were launched on the Internet by a recognised Swedish community site. Eligible study participants were invited to answer questions about their health with full anonymity as they logged in to their personal area on the website.

Results: A large number of responses were obtained, from approximately 750 to 1 600 for the 2007 and 2010 questionnaires, to around 130 000 when questions were asked separately in 2005. A high percentage of young subjects responded that they felt stressed very often/often; the numbers were higher for females (47%) than for males (29%). Older teenaged females had more psychosomatic complaints than did males of similar ages; in contrast, among 10- to 12-year-old children, the percentage of psychosomatic complaints was similar for males and females. When comparing results obtained in 2010 with those obtained in 2007, young people of both sexes had a slightly better self-perceived health status in 2007.

Conclusions: During the period 2005 to 2010 a high percentage of young people, particularly females 16 to 18 years of age, had psychosomatic complaints, and considered themselves as being often or very often stressed. These complaints were more pronounced in the older age groups. When directing questions to a large community, Internet-based surveys appear to be valuable tools.

Keywords: Self-perceived health, psychosomatic, children, adolescents

Introduction

Children's life situations have changed dramatically over the past decades. Several conditions in today's modern information-based society have exposed children to seemingly increased levels of stress in multiple ways [1-2]. Lupien et al. noted that risk factors for the development of stress reactions depend primarily on an individual's genetic vulnerability, exposure to adverse life events, socioeconomic situation, disturbances in important relationships, problems with school, and the timing of stressful events (3). Importantly, the development of stress reactions in young people is, to a great extent, gender-dependent (4,5,6). Thus, it seems plausible that several factors, both psychological and physical, play important roles in the development of stress reactions which will have an impact on children's well-being and ill health, with salient implications for future health and disease (7).

High frequencies of ill health such as complaints about perceived stress, and psychosomatic symptoms in children, adolescents, and young adults, particularly older teenage girls, have recently been reported in Sweden and internationally (8-13). The aim of this study was to obtain information both at a given time point and as a analysis at different time points about perceived stress and psychosomatic symptoms in Swedish subjects aged 10 to 24 years. To achieve this purpose, we needed a strategy that would feasibly allow us to ascertain a large number of respondents. Donker et al. (14) used screening questionnaires for common mental disorders and recommended that such questionnaires be administered via the Internet, which offers quick and easy access to a large number of users at a low cost. The screening must be brief, as subjects are more likely to undergo screening if it is short, quickly completed, and easy to read (14).

Our primary and main aim was to explore psychosomatic health problems among children and adolescents, focusing on sex and age differences, using a web-based protocol launched on a large internet community.

To our knowledge, this study is the first to use the Internet to examine self-perceived health and stress in large cohorts of children, adolescents, and young adults. Furthermore, as a secondary objective we explored possible changes in the percentages of self-reported health complaints over a three-year period from 2007 to 2010.

Methods

The present study used the Internet to assess psychosomatic health in young people using well-established questions (4,10,11), with the beneficial result of having a high number of respondents in each age and sex category. Each subject could log into her or his own "LunarStorm corner" and voluntarily choose to complete the questions on the community site, which would make the subjects more likely to provide honest answers. Compared with the response rates obtained from telephone or mail questionnaires, the number of responders per day may seem somewhat low. We received responses from 100,000 to 150,000 individuals per day, which represents approximately 36% of the entire population of members (1.2 million).

Data were collected via Internet-based questionnaires consisting of three parts: (i) a single question about "stress," launched on the Internet on a single day in January 2005. (ii) Eight questions about subjective health that were completed between 26 May and 28 June 2005. One question was delivered on each of eight separate days. (iii) The same eight questions (comprising a composite measure of subjective health),

delivered to smaller groups of randomly selected 15- to 20-year-olds on the same day in May 2007 and then again to a new age-matched group of randomly selected adolescents and young adults in May 2010. The subjects had complete freedom regarding whether to complete or abstain the questionnaire.

Apart from the single question about stress, the aforementioned eight questions were developed and tested for reliability and used by the Swedish National Board of Health and Welfare (www.socialstyrelsen.se) in studies of the psychological health and well-being of children and adolescents. The composite measure of subjective health (4) is comprised of the following items: difficulty concentrating, difficulty sleeping, suffers from headaches, suffers from stomach-aches, feels tense, poor appetite, feels low, and feels dizzy. The response categories for all of these items, which were delivered in question form, were “don’t know”; “no, never”; “no, seldom”; “yes, sometimes”; “yes, often”; and “yes, always”. The outcomes from psychometric Rasch analysis of the PSP scale have been reported in previous papers (15, 16). The analysis confirmed the appropriateness of considering somatic and psychological problems as interacting parts that constitute a higher-order, unidimensional construct (psychosomatic health). The scale showed valid psychometric properties and met the measurement requirements of invariance and proper item categorisation. The Rasch model further revealed that from a general level of analysis, the eight items were invariant among students with good health and among those with bad health. Importantly, these eight questions also work invariantly across time; i.e., there is no differential item functioning with respect to the year of investigation, which is a prerequisite for repeated analysis, as in the present study.

The item about stress was “How often/seldom do you feel stressed?”, and the response categories were “yes, very often”; “yes, often”; “yes, sometimes”; “no, seldom”; “no, very seldom”; “no, never”; and “don’t know”.

Initially, we placed one question per day on LunarStorm’s website, which was one of the first web communities to be established in Sweden. At the time of our investigations in 2005 and 2007, LunarStorm was the largest Internet community in Sweden. It had 1.3 million active members and approximately 360,000 unique visitors per day who spent approximately 40 minutes per visit on the site (TNS Gallup/Red Measure, Nielsen/Net Ratings). Eighty-three per cent of 15- to 20-year-olds in Sweden were LunarStorm members, and 25 out of 30 pupils in every secondary school class were members (Lunarworks AB/SCB). The gender distribution of members was 53% females.

Members saw the question after log-in, and only one answer per log-in was allowed and counted. We focused on children, adolescents, and young adults from 10 to 24 years old. The percentage of LunarStorm members in each age class in Sweden ranged from 20% to 88%, with the highest values (>80%) for adolescents between 13 and 16 years of age (Statistics Sweden, www.scb.se). The reason why we placed one question per day instead of presenting the whole eight item questionnaires at one single occasion was that the web community administrator had the experience that using such long composite questionnaires decreased the participation rate substantially. However, after receiving high response rates on the separate items we decided to include the whole eight item questionnaire at one specific time point.

The first set of eight questions was released on the Internet on a single day in 2007 to a group of 15- to 20-year-old subjects who were randomly selected by the community websites using statistical methods. Children and younger adolescents were not included, as they were in the protocol that presented one question per day. We chose to focus on 15- to 20-year-olds because of their higher response rate. Because questions released on separate days would attract a very large number of responders, we were able to divide the subjects not only into gender groups but also into various age groups (Table 1). In yet another Internet-based protocol using the same eight questions described above to determine self-perceived health trends, the subjects were randomly selected in both May 2007 and in May 2010 to respond to the questions. These groups comprised approximately 1,500 subjects aged 15 to 20 years (Table 2).

Ethical approval was obtained from the chairman of the review board. According to the ethical guidelines, posting questionnaires on the Internet does not require ethical approval from a committee. However, we choose to discuss these issues thoroughly with the chairman and received full approval.

Statistical analyses

The Mann-Whitney U test and the Kruskal-Wallis and chi-squared tests were used. Each of the possible responses to each of the eight questions in the Likert format was assigned a number ("no, never=1"; "no, seldom=2"; "yes, sometimes=3"; "yes, often=4"; and "yes, always=5"), which was multiplied by the response frequency and then averaged. The same procedure was performed with the item about stress and the response categories were "yes, very often=6"; "yes, often=5"; "yes, sometimes=4"; "no,

seldom=3"; "no, very seldom=2"; "no, never=1"; the answer "don't know" was not included in the statistical calculations. Statistical significance was considered when $p < 0.05$.

Results

Consistently more girls answered the questions, and there was an age-group related decline in the severity of self-perceived health; however, girls still reported higher frequencies of psychological ill-health during the whole investigated age-span. The peak of problems experienced occurred in adolescents aged 16 to 18 years, and females perceived the most problems.

Item about stress

The single question about stress received 148,395 responses (85,330 girls) from 10- to 24-year-olds. The vast majority of this population was between 10 and 24 years old. When analysing the total population, we found that 30% of the females and 19% of the males considered themselves stressed very often (Figure 1). Similarly, the response "yes, often" was provided more often by females: 17% vs. 10% in males ($p < 0.0001$). When the 10- to 24-year-old population was divided into age subgroups, we found that 16- to 18-year-old males and females reported the highest degree of stress (very often): 22% for males and 37% for females (Figure 2, $p < 0.0001$). The lowest number of subjects responding "yes, often" to stress was in the 10- to 12-year-old group. Consistently, females were significantly more likely to report higher levels of stress ("very often" and "often") than males from 10 to 24 years of age. The percentage of males responding "yes, very often" to the stress question remained relatively constant at 20% from 13 to 24 years of age, while the percentage of females responding "yes,

very often" increased until they reached 16 to 18 years old and levelled off for those who were 19 to 24 years old. However, this older female group still showed statistically significantly higher values for self-perceived stress than males of the same age (Figure 2). Males of all ages chose the alternative response "no, never" to the question about stress statistically more frequently than females (Figure 2).

Eight questions presented via the Internet on separate days to 10- to 24-year-olds (Table 1)

Given that these questions were placed one at a time, the response frequency varied between 12,000 and 45,000 subjects, who were mainly in the 10- to 12-year-old and 13- to 18-year-old age groups, respectively; the response frequencies for all eight questions were similar. When all of the possible responses to all eight questions were considered, we found that males of all age groups scored higher in terms of self-perceived health compared with females ($p < 0.0001$). The only exceptions in which there were no differences between males and females occurred in the 10- to 12-year-old group regarding difficulty concentrating ($p = 0.11$) and in the 19- to 24-year-old group regarding difficulty sleeping ($p = 0.16$).

An analysis of the four age groups' responses to all of the questions (except for the question regarding poor appetite) revealed that the older the subjects, the poorer their self-perceived health ($p < 0.0001$). Both females and males demonstrated poorer self-perceived health the older they were ($p < 0.0001$ for both, except for $p = 0.04$ for poor appetite in females). However, males reported fewer headaches ($p = 0.02$) and better appetite ($p = 0.003$) with increasing age. When we adjusted for the differences in sex, we found poorer self-perceived health with increasing age ($p < 0.0001$), with the exception of poor appetite ($p = 0.52$), which received opposite overall responses for

males and females, as described above. Similarly, when we adjusted for differences in age, we found better self-perceived health in males than in females ($p < 0.0001$).

Eight questions regarding self-perceived health presented together on the Internet in 2007 and 2010

Males reported better self-perceived health than females for all eight questions in the 2007 questionnaire (Figure 3, $p < 0.0001$). The results were similar in 2010, with males reporting better self-perceived health than females regarding headache, stomach-ache, feeling tense, poor appetite, feeling low, and feeling dizzy (Figure 3, $p < 0.0001$) as well as difficulty sleeping ($p = 0.002$). The difference between males and female regarding difficulty concentrating was not statistically significant ($p = 0.06$). There were subtle differences between the overall responses to the 2007 and 2010 questionnaires. Males demonstrated better self-perceived health in 2007 vs. 2010 regarding feeling low, poor appetite, feeling tense, and difficulty sleeping and concentrating (Table 2). Females presented a similar pattern of better self-perceived health, with the exception of poor appetite (no change). The items stomach-ache, headache, and feeling dizzy remained unchanged from 2007 to 2010 for both sexes (Table 2).

Discussion

We found marked differences between the sexes regarding psychosomatic symptoms, with females reporting higher degrees of stress compared with males across the large age span between 10 and 24 years of age. These symptoms appeared to be most pronounced between 16 and 18 years of age and then declined, supporting and extending the results of Hagquist (4). Similar findings using the same eight questionnaire items were reported previously (4,10); however, these findings came from smaller regional studies that administered the questionnaires in person

(by distributing them in schools). The present study used the Internet to assess psychosomatic health in young people using well-established questions (4,10,11), with a high number of respondents in each age and sex category. The fact that each subject could voluntarily and anonymously choose to complete the questions on the community site, could have made the subjects more prone to provide honest answers.

As shown in the present study and what has been noted previously (4,11), is that females are more likely than males in the same age group to report feeling stressed across both childhood, adolescence and as young adults. Notably, while females seem to increase their reporting of stress and psychosomatic symptoms from childhood to young adults, similar variables are remarkably constant from 13 to 24 years of age in males. These salient sex differences may be explained by the fact that there are real differences in stress levels and psychosomatic symptoms between the sexes, or that girls are more self-aware and reflecting and therefore more able to assess their psychological health, or that it is more culturally acceptable for girls to report psychosomatic symptoms, or a combination of the factors above. Boys might be more inclined to express themselves more physically, like being more active in sports, or pursue other forms of acting out behaviour (10).

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The eight-item scale we used was validated in several studies as an appropriate means of estimating the subjective health complaints of children and adolescents. The instrument was also examined with the Rasch model, for which invariance is essential (16,19). There are few data available regarding Internet-based surveys of psychological health among young people; thus, there are few validation analyses. Donker et al. (14) validated a brief web-based screening questionnaire for common mental disorders with follow-up phone interviews, using a "gold standard' interview guide to assess the presence of DSM-IV disorders in the previous 6 months. Their questionnaire screened for common mental disorders. However, the subjects in the present study could not be identified; thus, such a validation was not possible.

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Figure legends

Fig 1. Bars depict the percentage of “never” to “very often” responses to the question “How often/seldom do you feel stressed?” for 10- to 24-year-old females and males. The total number of respondents was 148 395. For the statistics, see the text.

Fig 2. Bars demonstrate the percentage of “never” and “very often” responses to the question “How often/seldom do you feel stressed?” divided by sex and age. The numbers in the graph represent the number of responding individuals. The statistics are reported in the text.

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Self-perceived psychosomatic health in Swedish children, adolescents, and young adults: An Internet-based survey over time

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Running title: Stress in youth examined via the Internet

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Summary

Article focus:

- Examining self-perceived health and stress in large cohorts of children, adolescents, and young adults who are members of a large, Swedish web-based community.
- Examining whether psychosomatic health deteriorated in adolescents between 2007 and 2010.
- Assessment of the usability of a large web-based community on the Internet to investigate self-perceived psychosomatic health in Swedish youth.

Key messages

- A high percentage of young subjects responded that they felt stressed very often/often, and the numbers were higher for females than for males.
- Older teenaged females had more psychosomatic complaints than males did.
- Both sexes reported a slightly worse self-perceived health status in 2010 than in 2007.
- Novel internet-based community site surveys are feasible for assessing self-perceived health in the young.

Strengths and limitations

- The study examined a very large cohort of children, adolescents and young adults from throughout Sweden.
- All subjects responded completely voluntarily.
- There may be a selection bias, given that we do not know the psychosomatic health of individuals who were not logged onto the website.
- Participation in the survey was completely anonymous; thus, we could not perform additional interviews to study the web questions' validity in this population.

Abstract

Objectives: We investigated self-perceived psychosomatic health in young people (10 to 24 years of age) in Sweden and analysed different samples during the years 2005, 2007 to 2010 via a community website.

Design: Repeated cross-sectional surveys: (i) a single question on a single day 2005. (ii) One specific question delivered on each of eight separate days 2005. (iii) The same eight questions, delivered to a smaller group of randomly selected 15- to 20-year-olds on the same day in 2007 and then again to a new age-matched group of randomly selected subjects in 2010. Validated questionnaires were launched on the Internet by a recognised Swedish community site. Eligible study participants were invited to answer questions about their health with full anonymity as they logged in to their personal area on the website.

Results: A large number of responses were obtained, from approximately 750 to 1 600 for the 2007 and 2010 questionnaires, to around 130 000 when questions were asked separately in 2005. A high percentage of young subjects responded that they felt stressed very often/often; the numbers were higher for females (47%) than for males (29%). Older teenaged females had more psychosomatic complaints than did males of similar ages; in contrast, among 10- to 12-year-old children, the percentage of psychosomatic complaints was similar for males and females. When comparing results obtained in 2010 with those obtained in 2007, young people of both sexes had a slightly better self-perceived health status in 2007.

Conclusions: During the period 2005 to 2010 a high percentage of young people, particularly females 16 to 18 years of age, had psychosomatic complaints, and considered themselves as being often or very often stressed. These complaints were more pronounced in the older age groups. When directing questions to a large community, Internet-based surveys appear to be valuable tools.

Keywords: Self-perceived health, psychosomatic, children, adolescents

Introduction

Children's life situations have changed dramatically over the past decades. Several conditions in today's modern information-based society have exposed children to seemingly increased levels of stress in multiple ways [1-2]. Lupien et al. noted that risk factors for the development of stress reactions depend primarily on an individual's genetic vulnerability, exposure to adverse life events, socioeconomic situation, disturbances in important relationships, problems with school, and the timing of stressful events (3). Importantly, the development of stress reactions in young people is, to a great extent, gender-dependent (4,5,6). Thus, it seems plausible that several factors, both psychological and physical, play important roles in the development of stress reactions which will have an impact on children's well-being and ill health, with salient implications for future health and disease (7).

High frequencies of ill health such as complaints about perceived stress, and psychosomatic symptoms in children, adolescents, and young adults, particularly older teenage girls, have recently been reported in Sweden and internationally (8-13). The aim of this study was to obtain information both at a given time point and as a analysis at different time points about perceived stress and psychosomatic symptoms in Swedish subjects aged 10 to 24 years. To achieve this purpose, we needed a strategy that would feasibly allow us to ascertain a large number of respondents. Donker et al. (14) used screening questionnaires for common mental disorders and recommended that such questionnaires be administered via the Internet, which offers quick and easy access to a large number of users at a low cost. The screening must be brief, as subjects are more likely to undergo screening if it is short, quickly completed, and easy to read (14).

Our primary and main aim was to explore psychosomatic health problems among children and adolescents, focusing on sex and age differences, using a web-based protocol launched on a large internet community.

To our knowledge, this study is the first to use the Internet to examine self-perceived health and stress in large cohorts of children, adolescents, and young adults. Furthermore, as a secondary objective we explored possible changes in the percentages of self-reported health complaints over a three-year period from 2007 to 2010.

Methods

The present study used the Internet to assess psychosomatic health in young people using well-established questions (4,10,11), with the beneficial result of having a high number of respondents in each age and sex category. Each subject could log into her or his own "LunarStorm corner" and voluntarily choose to complete the questions on the community site, which would make the subjects more likely to provide honest answers. Compared with the response rates obtained from telephone or mail questionnaires, the number of responders per day may seem somewhat low. We received responses from 100,000 to 150,000 individuals per day, which represents approximately 36% of the entire population of members (1.2 million).

Data were collected via Internet-based questionnaires consisting of three parts: (i) a single question about "stress," launched on the Internet on a single day in January 2005. (ii) Eight questions about subjective health that were completed between 26 May and 28 June 2005. One question was delivered on each of eight separate days. (iii) The same eight questions (comprising a composite measure of subjective health),

delivered to smaller groups of randomly selected 15- to 20-year-olds on the same day in May 2007 and then again to a new age-matched group of randomly selected adolescents and young adults in May 2010. The subjects had complete freedom regarding whether to complete or abstain the questionnaire.

Apart from the single question about stress, the aforementioned eight questions were developed and tested for reliability and used by the Swedish National Board of Health and Welfare (www.socialstyrelsen.se) in studies of the psychological health and well-being of children and adolescents. The composite measure of subjective health (4) is comprised of the following items: difficulty concentrating, difficulty sleeping, suffers from headaches, suffers from stomach-aches, feels tense, poor appetite, feels low, and feels dizzy. The response categories for all of these items, which were delivered in question form, were “don’t know”; “no, never”; “no, seldom”; “yes, sometimes”; “yes, often”; and “yes, always”. The outcomes from psychometric Rasch analysis of the PSP scale have been reported in previous papers (15, 16). The analysis confirmed the appropriateness of considering somatic and psychological problems as interacting parts that constitute a higher-order, unidimensional construct (psychosomatic health). The scale showed valid psychometric properties and met the measurement requirements of invariance and proper item categorisation. The Rasch model further revealed that from a general level of analysis, the eight items were invariant among students with good health and among those with bad health. Importantly, these eight questions also work invariantly across time; i.e., there is no differential item functioning with respect to the year of investigation, which is a prerequisite for repeated analysis, as in the present study.

The item about stress was “How often/seldom do you feel stressed?”, and the response categories were “yes, very often”; “yes, often”; “yes, sometimes”; “no, seldom”; “no, very seldom”; “no, never”; and “don’t know”.

Initially, we placed one question per day on LunarStorm’s website, which was one of the first web communities to be established in Sweden. At the time of our investigations in 2005 and 2007, LunarStorm was the largest Internet community in Sweden. It had 1.3 million active members and approximately 360,000 unique visitors per day who spent approximately 40 minutes per visit on the site (TNS Gallup/Red Measure, Nielsen/Net Ratings). Eighty-three per cent of 15- to 20-year-olds in Sweden were LunarStorm members, and 25 out of 30 pupils in every secondary school class were members (Lunarworks AB/SCB). The gender distribution of members was 53% females.

Members saw the question after log-in, and only one answer per log-in was allowed and counted. We focused on children, adolescents, and young adults from 10 to 24 years old. The percentage of LunarStorm members in each age class in Sweden ranged from 20% to 88%, with the highest values (>80%) for adolescents between 13 and 16 years of age (Statistics Sweden, www.scb.se). The reason why we placed one question per day instead of presenting the whole eight item questionnaires at one single occasion was that the web community administrator had the experience that using such long composite questionnaires decreased the participation rate substantially. However, after receiving high response rates on the separate items we decided to include the whole eight item questionnaire at one specific time point.

The first set of eight questions was released on the Internet on a single day in 2007 to a group of 15- to 20-year-old subjects who were randomly selected by the community websites using statistical methods. Children and younger adolescents were not included, as they were in the protocol that presented one question per day. We chose to focus on 15- to 20-year-olds because of their higher response rate. Because questions released on separate days would attract a very large number of responders, we were able to divide the subjects not only into gender groups but also into various age groups (Table 1). In yet another Internet-based protocol using the same eight questions described above to determine self-perceived health trends, the subjects were randomly selected in both May 2007 and in May 2010 to respond to the questions. These groups comprised approximately 1,500 subjects aged 15 to 20 years (Table 2).

Ethical approval was obtained from the chairman of the review board. According to the ethical guidelines, posting questionnaires on the Internet does not require ethical approval from a committee. However, we choose to discuss these issues thoroughly with the chairman and received full approval.

Statistical analyses

The Mann-Whitney U test and the Kruskal-Wallis and chi-squared tests were used. Each of the possible responses to each of the eight questions in the Likert format was assigned a number (“no, never=1”; “no, seldom=2”; “yes, sometimes=3”; “yes, often=4”; and “yes, always=5”), which was multiplied by the response frequency and then averaged. The same procedure was performed with the item about stress and the response categories were “yes, very often=6”; “yes, often=5”; “yes, sometimes=4”; “no,

seldom=3"; "no, very seldom=2"; "no, never=1"; the answer "don't know" was not included in the statistical calculations. Statistical significance was considered when $p < 0.05$.

Results

Consistently more girls answered the questions, and there was an age-group related decline in the severity of self-perceived health; however, girls still reported higher frequencies of psychological ill-health during the whole investigated age-span. The peak of problems experienced occurred in adolescents aged 16 to 18 years, and females perceived the most problems.

Item about stress

The single question about stress received 148,395 responses (85,330 girls) from 10- to 24-year-olds. The vast majority of this population was between 10 and 24 years old. When analysing the total population, we found that 30% of the females and 19% of the males considered themselves stressed very often (Figure 1). Similarly, the response "yes, often" was provided more often by females: 17% vs. 10% in males ($p < 0.0001$). When the 10- to 24-year-old population was divided into age subgroups, we found that 16- to 18-year-old males and females reported the highest degree of stress (very often): 22% for males and 37% for females (Figure 2, $p < 0.0001$). The lowest number of subjects responding "yes, often" to stress was in the 10- to 12-year-old group. Consistently, females were significantly more likely to report higher levels of stress ("very often" and "often") than males from 10 to 24 years of age. The percentage of males responding "yes, very often" to the stress question remained relatively constant at 20% from 13 to 24 years of age, while the percentage of females responding "yes,

very often" increased until they reached 16 to 18 years old and levelled off for those who were 19 to 24 years old. However, this older female group still showed statistically significantly higher values for self-perceived stress than males of the same age (Figure 2). Males of all ages chose the alternative response "no, never" to the question about stress statistically more frequently than females (Figure 2).

Eight questions presented via the Internet on separate days to 10- to 24-year-olds (Table 1)

Given that these questions were placed one at a time, the response frequency varied between 12,000 and 45,000 subjects, who were mainly in the 10- to 12-year-old and 13- to 18-year-old age groups, respectively; the response frequencies for all eight questions were similar. When all of the possible responses to all eight questions were considered, we found that males of all age groups scored higher in terms of self-perceived health compared with females ($p < 0.0001$). The only exceptions in which there were no differences between males and females occurred in the 10- to 12-year-old group regarding difficulty concentrating ($p = 0.11$) and in the 19- to 24-year-old group regarding difficulty sleeping ($p = 0.16$).

An analysis of the four age groups' responses to all of the questions (except for the question regarding poor appetite) revealed that the older the subjects, the poorer their self-perceived health ($p < 0.0001$). Both females and males demonstrated poorer self-perceived health the older they were ($p < 0.0001$ for both, except for $p = 0.04$ for poor appetite in females). However, males reported fewer headaches ($p = 0.02$) and better appetite ($p = 0.003$) with increasing age. When we adjusted for the differences in sex, we found poorer self-perceived health with increasing age ($p < 0.0001$), with the exception of poor appetite ($p = 0.52$), which received opposite overall responses for

males and females, as described above. Similarly, when we adjusted for differences in age, we found better self-perceived health in males than in females ($p < 0.0001$).

Eight questions regarding self-perceived health presented together on the Internet in 2007 and 2010

Males reported better self-perceived health than females for all eight questions in the 2007 questionnaire (Figure 3, $p < 0.0001$). The results were similar in 2010, with males reporting better self-perceived health than females regarding headache, stomach-ache, feeling tense, poor appetite, feeling low, and feeling dizzy (Figure 3, $p < 0.0001$) as well as difficulty sleeping ($p = 0.002$). The difference between males and female regarding difficulty concentrating was not statistically significant ($p = 0.06$). There were subtle differences between the overall responses to the 2007 and 2010 questionnaires. Males demonstrated better self-perceived health in 2007 vs. 2010 regarding feeling low, poor appetite, feeling tense, and difficulty sleeping and concentrating (Table 2). Females presented a similar pattern of better self-perceived health, with the exception of poor appetite (no change). The items stomach-ache, headache, and feeling dizzy remained unchanged from 2007 to 2010 for both sexes (Table 2).

Discussion

We found marked differences between the sexes regarding psychosomatic symptoms, with females reporting higher degrees of stress compared with males across the large age span between 10 and 24 years of age. These symptoms appeared to be most pronounced between 16 and 18 years of age and then declined, supporting and extending the results of Hagquist (4). Similar findings using the same eight questionnaire items were reported previously (4,10); however, these findings came from smaller regional studies that administered the questionnaires in person

(by distributing them in schools). The present study used the Internet to assess psychosomatic health in young people using well-established questions (4,10,11), with a high number of respondents in each age and sex category. The fact that each subject could voluntarily and anonymously choose to complete the questions on the community site, could have made the subjects more prone to provide honest answers.

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CONTRIBUTORSHIP STATEMENT

PF had the main responsibility for designing, analysing data, and shared the main responsibility for drafting the manuscript with WO. WO also took active part in designing questions regarding psychosocial health and reviewing data analysis. CH took active part in designing questions regarding psychosocial health, reviewing data analysis and made important commentaries on the text. Authors approve the present version to be published.

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TABLE 1

Proportion responders in % of 8 questions assessing self-perceived health asked on the web in May 2005. The column "don´t know" is not included in the subsequent calculations

Question/alternative	Yes, always	Yes, often	Yes, some-times	No, seldom	No, never	don´t know	Number of responders	Sex, %
Difficulty in concentrating								
10-12 years old								
-females	7	8	40	17	11	17	7526	63,4
-males	12	7	34	17	16	15	4341	36,6
13-15 years old								
-females	14	17	45	11	5	8	28889	62,2
-males	16	12	40	13	9	9	17544	37,8
16-18 years old								
-females	17	25	45	7	2	4	23846	56,0
-males	19	15	41	12	7	6	18756	44,0
19-24 years old								
-females	12	24	47	9	3	5	15114	53,2
-males	14	14	44	15	7	7	13318	46,8
Difficulty in sleeping								
10-12 years old								
-females	8	7	38	25	14	8	8229	63,8
-males	10	5	31	25	22	7	4673	36,2
13-15 years old								
-females	11	10	41	24	10	5	29133	62,4
-males	13	6	31	27	18	5	17546	37,6
16-18 years old								
-females	12	13	45	20	7	2	23525	56,8
-males	15	8	34	23	16	3	17923	43,2
19-24 years old								
-females	11	16	46	19	6	1	15430	54,3
-males	14	12	39	21	12	2	13007	45,7
Suffering from headache								
10-12 years old								
-females	9	12	40	22	9	8	8867	64,8
-males	11	8	34	23	15	9	4825	35,2
13-15 years old								
-females	13	16	42	20	6	4	27817	62,5
-males	13	8	35	26	12	5	16657	37,5
16-18 years old								
-females	13	19	45	17	4	2	19145	56,1
-males	12	7	37	28	12	4	14984	43,9
19-24 years old								
-females	9	22	48	17	3	1	12368	53,5
-males	9	8	39	30	11	3	10737	46,5
Suffering from stomach pain								
10-12 years old								
-females	7	9	35	22	12	15	7978	64,7
-males	9	5	24	23	22	17	4351	35,3
13-15 years old								
-females	9	13	42	20	8	8	27147	63,6
-males	12	5	26	24	21	11	15546	36,4
16-18 years old								
-females	10	17	45	18	6	4	19364	56,6
-males	11	5	28	26	21	9	14836	43,4
19-24 years old								
-females	10	20	47	16	4	3	12836	54,0
-males	8	7	32	27	18	8	10926	46,0

Table 1 cont´d

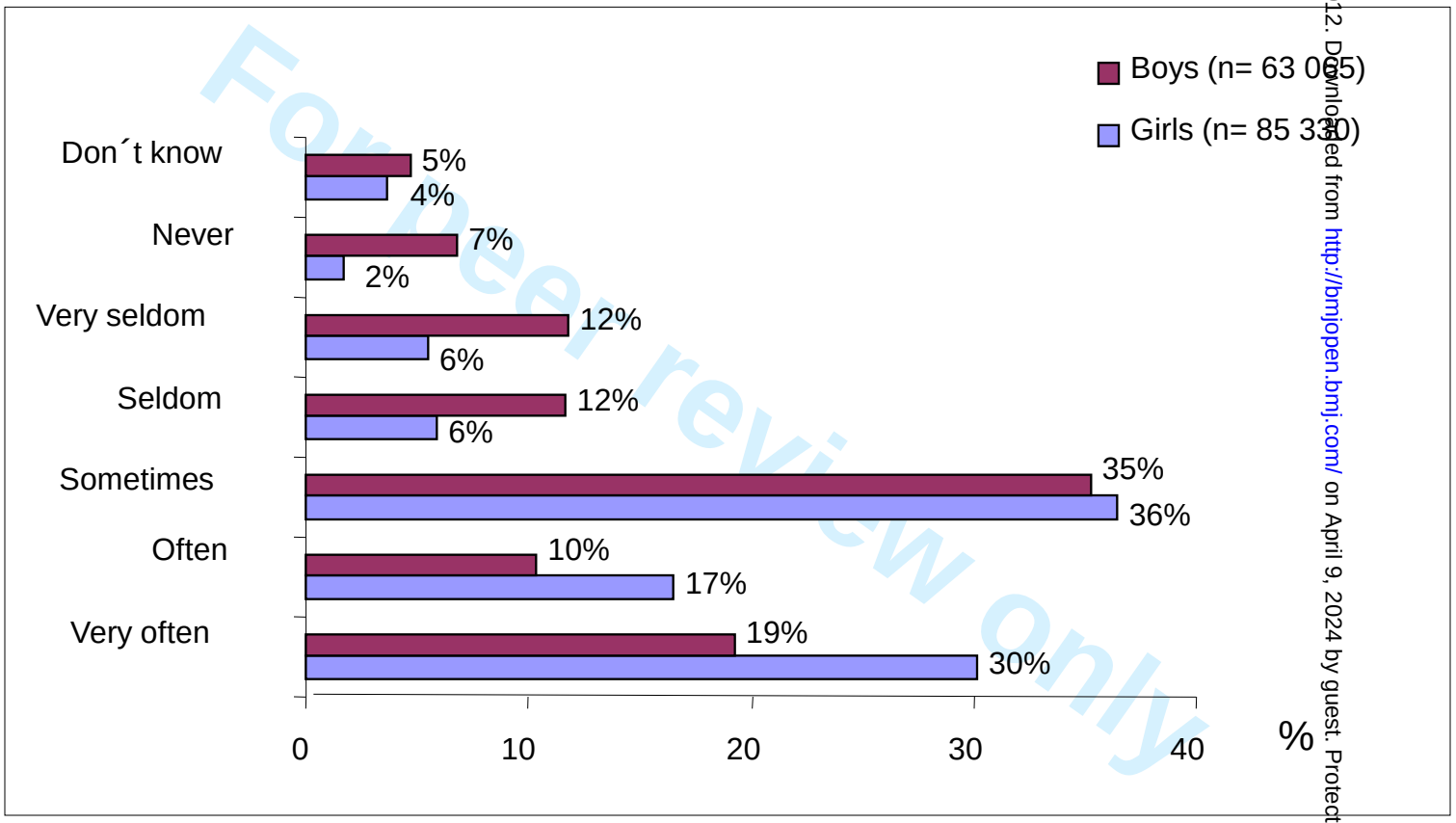
Question/alternative	Yes, always	Yes, often	Yes, sometimes	No, seldom	No, never	don´t know	Number of responders	Sex, %
Feeling tense								
10-12 years old								
-females	6	7	32	21	11	23	7477	61,2
-males	10	4	28	20	18	19	4749	38,8
13-15 years old								
-females	9	14	38	16	6	16	25342	59,6
-males	14	6	32	18	15	14	17195	40,4
16-18 years old								
-females	13	24	40	11	4	9	18230	53,4
-males	15	9	38	16	13	9	15888	46,6
19-24 years old								
-females	14	25	46	7	3	5	13056	53,9
-males	14	13	43	14	8	7	11170	46,1
Poor appetite								
10-12 years old								
-females	7	6	30	21	17	19	7887	63,9
-males	9	4	23	21	25	18	4457	36,1
13-15 years old								
-females	8	8	36	21	16	11	26356	62,5
-males	11	4	23	22	29	12	15786	37,5
16-18 years old								
-females	7	9	41	21	16	6	17385	55,1
-males	10	4	26	21	31	8	14168	44,9
19-24 years old								
-females	5	9	42	22	18	4	10611	52,7
-males	7	5	30	22	30	6	9527	47,3
Feeling low								
10-12 years old								
-females	9	15	45	16	6	8	9458	65,5
-males	10	7	33	23	16	11	4978	34,5
13-15 years old								
-females	13	24	44	11	4	4	31107	63,6
-males	12	8	35	23	15	8	17793	36,4
16-18 years old								
-females	12	30	47	8	2	2	23174	58,0
-males	11	11	41	20	11	16	16799	42,0
19-24 years old								
-females	9	30	51	8	1	1	15731	55,4
-males	9	14	47	19	7	5	12665	44,6
Feeling dizzy								
10-12 years old								
-females	6	8	41	23	10	13	7372	64,2
-males	10	6	34	23	16	11	4101	35,8
13-15 years old								
-females	9	13	46	18	6	8	24737	62,1
-males	14	7	36	22	12	8	15106	37,9
16-18 years old								
-females	8	16	51	16	4	5	18125	56,1
-males	13	8	40	21	11	7	14189	43,9
19-24 years old								
-females	5	15	54	16	5	5	12704	54,5
-males	10	8	44	21	10	7	10592	45,5

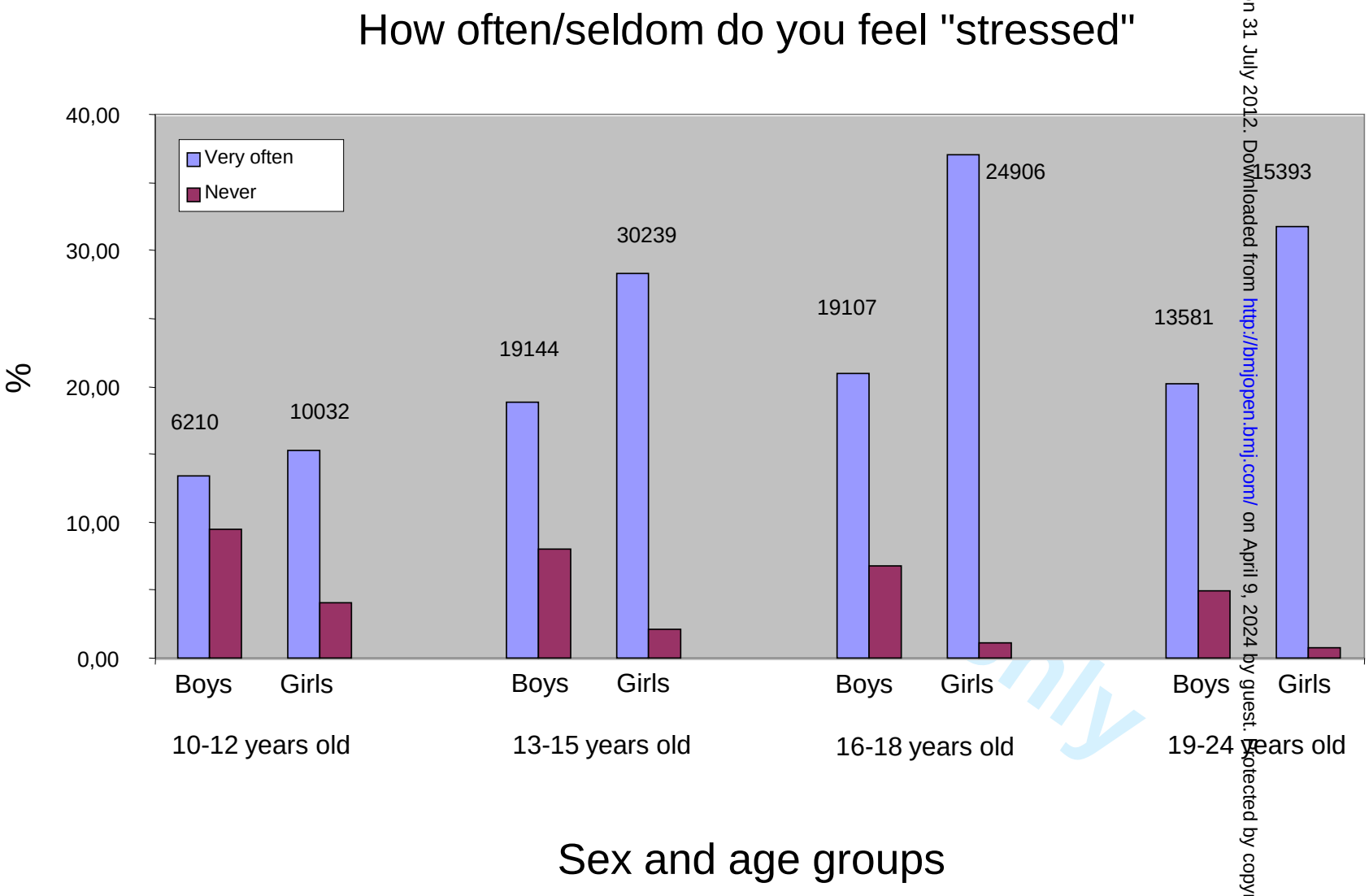
TABLE 2

Adolescents and young adults, aged 15 - 20 years responding to the same questions about self perceived psycho-somatic health (SPH) at two occasions, 2007 and 2010, respectively.

Question/alternative	Females change in SPH 2007 vs 2010, p and interpretation	Number of female responders 2007 and 2010	Males change in SPH 2007 vs 2010, p and inter pretation	Number of male responders 2007 and 2010
Difficulty in concentrating	0.04, better 2007	854, 1634	0.001, better 2007	808, 387
Difficulty in sleeping	0.004, better 2007	858, 1637	0.008, better 2007	818, 390
Suffered from headache	0.27, no difference	860, 1637	0.23, no difference	815, 388
Suffered from stomach ache	0.82, no difference	843, 1622	0.27, no difference	779, 380
Feeling tense	<0.0001, better 2007	837, 1599	<0.0001, better 2007	788, 382
Poor appetite	0.30, no difference	851, 1623	<0.0001, better 2007	797, 389
Feeling low	0.001, better 2007	864, 1635	0.0002, better 2007	804, 387
Feeling dizzy	0.29, no difference	838, 1618	0.16, no difference	793, 380

Fig 1





Self-perceived psychosomatic health in Swedish children, adolescents, and young adults: An Internet-based survey over time

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Running title: Stress in youth examined via the Internet

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Summary

Article focus:

- Examining self-perceived health and stress in large cohorts of children, adolescents, and young adults who are members of a large, Swedish web-based community.
- Examining whether psychosomatic health deteriorated in adolescents between 2007 and 2010.
- Assessment of the usability of a large web-based community on the Internet to investigate self-perceived psychosomatic health in Swedish youth.

Key messages

- A high percentage of young subjects responded that they felt stressed very often/often, and the numbers were higher for females than for males.
- Older teenaged females had more psychosomatic complaints than males did.
- Both sexes reported a slightly worse self-perceived health status in 2010 than in 2007.
- Novel internet-based community site surveys are feasible for assessing self-perceived health in the young.

Strengths and limitations

- The study examined a very large cohort of children, adolescents and young adults from throughout Sweden.
- All subjects responded completely voluntarily.
- There may be a selection bias, given that we do not know the psychosomatic health of individuals who were not logged onto the website.
- Participation in the survey was completely anonymous; thus, we could not perform additional interviews to study the web questions' validity in this population.

Abstract

Objectives: We investigated self-perceived psychosomatic health in young people (10 to 24 years of age) in Sweden and analysed different samples during the years 2005, 2007 to 2010 via a community website.

Design: Repeated cross-sectional surveys: (i) a single question on a single day 2005. (ii) One specific question delivered on each of eight separate days 2005. (iii) The same eight questions, delivered to a smaller group of randomly selected 15- to 20-year-olds on the same day in 2007 and then again to a new age-matched group of randomly selected subjects in 2010. Validated questionnaires were launched on the Internet by a recognised Swedish community site. Eligible study participants were invited to answer questions about their health with full anonymity as they logged in to their personal area on the website.

Results: A large number of responses were obtained, from approximately 750 to 1 600 for the 2007 and 2010 questionnaires, to around 130 000 when questions were asked separately in 2005. A high percentage of young subjects responded that they felt stressed very often/often; the numbers were higher for females (47%) than for males (29%). Older teenaged females had more psychosomatic complaints than did males of similar ages; in contrast, among 10- to 12-year-old children, the percentage of psychosomatic complaints was similar for males and females. When comparing results obtained in 2010 with those obtained in 2007, young people of both sexes had a slightly better self-perceived health status in 2007.

Conclusions: During the period 2005 to 2010 a high percentage of young people, particularly females 16 to 18 years of age, had psychosomatic complaints, and considered themselves as being often or very often stressed. These complaints were more pronounced in the older age groups. When directing questions to a large community, Internet-based surveys appear to be valuable tools.

Keywords: Self-perceived health, psychosomatic, children, adolescents

Introduction

Children's life situations have changed dramatically over the past decades. Several conditions in today's modern information-based society have exposed children to seemingly increased levels of stress in multiple ways [1-2]. Lupien et al. noted that risk factors for the development of stress reactions depend primarily on an individual's genetic vulnerability, exposure to adverse life events, socioeconomic situation, disturbances in important relationships, problems with school, and the timing of stressful events (3). Importantly, the development of stress reactions in young people is, to a great extent, gender-dependent (4,5,6). Thus, it seems plausible that several factors, both psychological and physical, play important roles in the development of stress reactions which will have an impact on children's well-being and ill health, with salient implications for future health and disease (7).

High frequencies of ill health such as complaints about perceived stress, and psychosomatic symptoms in children, adolescents, and young adults, particularly older teenage girls, have recently been reported in Sweden and internationally (8-13). The aim of this study was to obtain information both at a given time point and as a analysis at different time points about perceived stress and psychosomatic symptoms in Swedish subjects aged 10 to 24 years. To achieve this purpose, we needed a strategy that would feasibly allow us to ascertain a large number of respondents. Donker et al. (14) used screening questionnaires for common mental disorders and recommended that such questionnaires be administered via the Internet, which offers quick and easy access to a large number of users at a low cost. The screening must be brief, as subjects are more likely to undergo screening if it is short, quickly completed, and easy to read (14).

Our primary and main aim was to explore psychosomatic health problems among children and adolescents, focusing on sex and age differences, using a web-based protocol launched on a large internet community.

To our knowledge, this study is the first to use the Internet to examine self-perceived health and stress in large cohorts of children, adolescents, and young adults. Furthermore, as a secondary objective we explored possible changes in the percentages of self-reported health complaints over a three-year period from 2007 to 2010.

Methods

The present study used the Internet to assess psychosomatic health in young people using well-established questions (4,10,11), with the beneficial result of having a high number of respondents in each age and sex category. Each subject could log into her or his own "LunarStorm corner" and voluntarily choose to complete the questions on the community site, which would make the subjects more likely to provide honest answers. Compared with the response rates obtained from telephone or mail questionnaires, the number of responders per day may seem somewhat low. We received responses from 100,000 to 150,000 individuals per day, which represents approximately 36% of the entire population of members (1.2 million).

Data were collected via Internet-based questionnaires consisting of three parts: (i) a single question about "stress," launched on the Internet on a single day in January 2005. (ii) Eight questions about subjective health that were completed between 26 May and 28 June 2005. One question was delivered on each of eight separate days. (iii) The same eight questions (comprising a composite measure of subjective health),

delivered to smaller groups of randomly selected 15- to 20-year-olds on the same day in May 2007 and then again to a new age-matched group of randomly selected adolescents and young adults in May 2010. The subjects had complete freedom regarding whether to complete or abstain the questionnaire.

Apart from the single question about stress, the aforementioned eight questions were developed and tested for reliability and used by the Swedish National Board of Health and Welfare (www.socialstyrelsen.se) in studies of the psychological health and well-being of children and adolescents. The composite measure of subjective health (4) is comprised of the following items: difficulty concentrating, difficulty sleeping, suffers from headaches, suffers from stomach-aches, feels tense, poor appetite, feels low, and feels dizzy. The response categories for all of these items, which were delivered in question form, were “don’t know”; “no, never”; “no, seldom”; “yes, sometimes”; “yes, often”; and “yes, always”. The outcomes from psychometric Rasch analysis of the PSP scale have been reported in previous papers (15, 16). The analysis confirmed the appropriateness of considering somatic and psychological problems as interacting parts that constitute a higher-order, unidimensional construct (psychosomatic health). The scale showed valid psychometric properties and met the measurement requirements of invariance and proper item categorisation. The Rasch model further revealed that from a general level of analysis, the eight items were invariant among students with good health and among those with bad health. Importantly, these eight questions also work invariantly across time; i.e., there is no differential item functioning with respect to the year of investigation, which is a prerequisite for repeated analysis, as in the present study.

The item about stress was “How often/seldom do you feel stressed?”, and the response categories were “yes, very often”; “yes, often”; “yes, sometimes”; “no, seldom”; “no, very seldom”; “no, never”; and “don’t know”.

Initially, we placed one question per day on LunarStorm’s website, which was one of the first web communities to be established in Sweden. At the time of our investigations in 2005 and 2007, LunarStorm was the largest Internet community in Sweden. It had 1.3 million active members and approximately 360,000 unique visitors per day who spent approximately 40 minutes per visit on the site (TNS Gallup/Red Measure, Nielsen/Net Ratings). Eighty-three per cent of 15- to 20-year-olds in Sweden were LunarStorm members, and 25 out of 30 pupils in every secondary school class were members (Lunarworks AB/SCB). The gender distribution of members was 53% females.

Members saw the question after log-in, and only one answer per log-in was allowed and counted. We focused on children, adolescents, and young adults from 10 to 24 years old. The percentage of LunarStorm members in each age class in Sweden ranged from 20% to 88%, with the highest values (>80%) for adolescents between 13 and 16 years of age (Statistics Sweden, www.scb.se). The reason why we placed one question per day instead of presenting the whole eight item questionnaires at one single occasion was that the web community administrator had the experience that using such long composite questionnaires decreased the participation rate substantially. However, after receiving high response rates on the separate items we decided to include the whole eight item questionnaire at one specific time point.

The first set of eight questions was released on the Internet on a single day in 2007 to a group of 15- to 20-year-old subjects who were randomly selected by the community websites using statistical methods. Children and younger adolescents were not included, as they were in the protocol that presented one question per day. We chose to focus on 15- to 20-year-olds because of their higher response rate. Because questions released on separate days would attract a very large number of responders, we were able to divide the subjects not only into gender groups but also into various age groups (Table 1). In yet another Internet-based protocol using the same eight questions described above to determine self-perceived health trends, the subjects were randomly selected in both May 2007 and in May 2010 to respond to the questions. These groups comprised approximately 1,500 subjects aged 15 to 20 years (Table 2).

Ethical approval was obtained from the chairman of the review board. According to the ethical guidelines, posting questionnaires on the Internet does not require ethical approval from a committee. However, we choose to discuss these issues thoroughly with the chairman and received full approval.

Statistical analyses

The Mann-Whitney U test and the Kruskal-Wallis and chi-squared tests were used. Each of the possible responses to each of the eight questions in the Likert format was assigned a number ("no, never=1"; "no, seldom=2"; "yes, sometimes=3"; "yes, often=4"; and "yes, always=5"), which was multiplied by the response frequency and then averaged. The same procedure was performed with the item about stress and the response categories were "yes, very often=6"; "yes, often=5"; "yes, sometimes=4"; "no,

seldom=3"; "no, very seldom=2"; "no, never=1"; the answer "don't know" was not included in the statistical calculations. Statistical significance was considered when $p < 0.05$.

Results

Consistently more girls answered the questions, and there was an age-group related decline in the severity of self-perceived health; however, girls still reported higher frequencies of psychological ill-health during the whole investigated age-span. The peak of problems experienced occurred in adolescents aged 16 to 18 years, and females perceived the most problems.

Item about stress

The single question about stress received 148,395 responses (85,330 girls) from 10- to 24-year-olds. The vast majority of this population was between 10 and 24 years old. When analysing the total population, we found that 30% of the females and 19% of the males considered themselves stressed very often (Figure 1). Similarly, the response "yes, often" was provided more often by females: 17% vs. 10% in males ($p < 0.0001$). When the 10- to 24-year-old population was divided into age subgroups, we found that 16- to 18-year-old males and females reported the highest degree of stress (very often): 22% for males and 37% for females (Figure 2, $p < 0.0001$). The lowest number of subjects responding "yes, often" to stress was in the 10- to 12-year-old group. Consistently, females were significantly more likely to report higher levels of stress ("very often" and "often") than males from 10 to 24 years of age. The percentage of males responding "yes, very often" to the stress question remained relatively constant at 20% from 13 to 24 years of age, while the percentage of females responding "yes,

very often" increased until they reached 16 to 18 years old and levelled off for those who were 19 to 24 years old. However, this older female group still showed statistically significantly higher values for self-perceived stress than males of the same age (Figure 2). Males of all ages chose the alternative response "no, never" to the question about stress statistically more frequently than females (Figure 2).

Eight questions presented via the Internet on separate days to 10- to 24-year-olds (Table 1)

Given that these questions were placed one at a time, the response frequency varied between 12,000 and 45,000 subjects, who were mainly in the 10- to 12-year-old and 13- to 18-year-old age groups, respectively; the response frequencies for all eight questions were similar. When all of the possible responses to all eight questions were considered, we found that males of all age groups scored higher in terms of self-perceived health compared with females ($p < 0.0001$). The only exceptions in which there were no differences between males and females occurred in the 10- to 12-year-old group regarding difficulty concentrating ($p = 0.11$) and in the 19- to 24-year-old group regarding difficulty sleeping ($p = 0.16$).

An analysis of the four age groups' responses to all of the questions (except for the question regarding poor appetite) revealed that the older the subjects, the poorer their self-perceived health ($p < 0.0001$). Both females and males demonstrated poorer self-perceived health the older they were ($p < 0.0001$ for both, except for $p = 0.04$ for poor appetite in females). However, males reported fewer headaches ($p = 0.02$) and better appetite ($p = 0.003$) with increasing age. When we adjusted for the differences in sex, we found poorer self-perceived health with increasing age ($p < 0.0001$), with the exception of poor appetite ($p = 0.52$), which received opposite overall responses for

males and females, as described above. Similarly, when we adjusted for differences in age, we found better self-perceived health in males than in females ($p < 0.0001$).

Eight questions regarding self-perceived health presented together on the Internet in 2007 and 2010

Males reported better self-perceived health than females for all eight questions in the 2007 questionnaire (Figure 3, $p < 0.0001$). The results were similar in 2010, with males reporting better self-perceived health than females regarding headache, stomach-ache, feeling tense, poor appetite, feeling low, and feeling dizzy (Figure 3, $p < 0.0001$) as well as difficulty sleeping ($p = 0.002$). The difference between males and female regarding difficulty concentrating was not statistically significant ($p = 0.06$). There were subtle differences between the overall responses to the 2007 and 2010 questionnaires. Males demonstrated better self-perceived health in 2007 vs. 2010 regarding feeling low, poor appetite, feeling tense, and difficulty sleeping and concentrating (Table 2). Females presented a similar pattern of better self-perceived health, with the exception of poor appetite (no change). The items stomach-ache, headache, and feeling dizzy remained unchanged from 2007 to 2010 for both sexes (Table 2).

Discussion

We found marked differences between the sexes regarding psychosomatic symptoms, with females reporting higher degrees of stress compared with males across the large age span between 10 and 24 years of age. These symptoms appeared to be most pronounced between 16 and 18 years of age and then declined, supporting and extending the results of Hagquist (4). Similar findings using the same eight questionnaire items were reported previously (4,10); however, these findings came from smaller regional studies that administered the questionnaires in person

(by distributing them in schools). The present study used the Internet to assess psychosomatic health in young people using well-established questions (4,10,11), with a high number of respondents in each age and sex category. The fact that each subject could voluntarily and anonymously choose to complete the questions on the community site, could have made the subjects more prone to provide honest answers.

As shown in the present study and what has been noted previously (4,11), is that females are more likely than males in the same age group to report feeling stressed across both childhood, adolescence and as young adults. Notably, while females seem to increase their reporting of stress and psychosomatic symptoms from childhood to young adults, similar variables are remarkably constant from 13 to 24 years of age in males. These salient sex differences may be explained by the fact that there are real differences in stress levels and psychosomatic symptoms between the sexes, or that girls are more self-aware and reflecting and therefore more able to assess their psychological health, or that it is more culturally acceptable for girls to report psychosomatic symptoms, or a combination of the factors above. Boys might be more inclined to express themselves more physically, like being more active in sports, or pursue other forms of acting out behaviour (10).

For several, but not all, of the questions, self-perceived health was better in 2007 than in 2010 for both males and females perhaps reflecting the financial crisis that emerged in 2008. Although the changes between 2007 and 2010 were quite small, and the time elapsed was perhaps too short, we did note similar differences between males' and females' responses in 2005, 2007, and 2010. Self-perceived health was undoubtedly worse for females than for males, irrespective of age; this finding is supported by

earlier studies (5,6) and the results of Osika et al. (12), who used Beck Youth Inventory questionnaires.

Our data, together with the results of previous studies (4,8,12,13,17), point unequivocally to impaired self-reported psychological and psychosomatic health in the young, and the prevailing situation and trend do not seem to be improving. The psychosomatic health of young females is of particular concern, given the increase in complaints that appears to have occurred over the past 20 years, as indicated by surveys in Sweden (4). However, the figures regarding alcohol problems, criminality, and suicide are much higher for males than for females in the 16- to 24-year-old group (10).

Given that the majority of the subjects in the present study was school-aged, the school environment is an important factor to consider. Previous reports established links between the school environment and the psychological and psychosomatic symptoms of schoolchildren (9,18). In fact, Hjern et al. (13) demonstrated an association between school stressors, such as harassment by peers, schoolwork pressure, and being treated poorly by teachers, as well as psychosomatic pain and psychological problems, reflected as sadness, irritability, and feeling unsafe and nervous. In the light of our demonstrated sex differences also during school-age, one may surmise that factors related to school environment might affect girls and boys differently.

Methodological considerations and limitations

The eight-item scale we used was validated in several studies as an appropriate means of estimating the subjective health complaints of children and adolescents. The instrument was also examined with the Rasch model, for which invariance is essential (16,19). There are few data available regarding Internet-based surveys of psychological health among young people; thus, there are few validation analyses. Donker et al. (14) validated a brief web-based screening questionnaire for common mental disorders with follow-up phone interviews, using a "gold standard' interview guide to assess the presence of DSM-IV disorders in the previous 6 months. Their questionnaire screened for common mental disorders. However, the subjects in the present study could not be identified; thus, such a validation was not possible.

A study by Mangunkusumu et al. (20) demonstrated good agreement between responses to questionnaires that were handed out manually and those administered via the Internet. Notably, the Internet approach received more favourable evaluations, even though it also took place in a school milieu. A major advantage of the present study was that the subjects could choose whether to answer the questions while in a familiar private and comfortable environment. Furthermore, such administrative factors as data transcription, the risk of excluded values and "odd" answers, and the concern that other people might read the answers can be overcome by computer- and Internet-based surveys. Thus, Internet surveys assessing psychological health and well-being issues appear to be quite suitable for use with young people.

Approximately 350,000 people logged in on a given day, raising the possibility of selection bias. Because the subjects were anonymous, we could not investigate selection effects. However, a recent study using the Internet for health-related topics was independent of gender, age and diagnostic group in a group of patients with

psychosomatic disorders (21). Although the design of that study was not entirely comparable with the present study, it is an indication of that there was limited selection bias in our study. Additionally, the response rate obtained at LunarStorm was very high for such a generalised Internet-based survey.

Conclusion

A relatively high percentage of young people, particularly females 16 to 18 years of age, had psychosomatic complaints that did not seem to improve between 2007 and 2010. A considerable worsening of these complaints occurred from the age of 12 years onwards in both sexes. Internet-based survey assessment appears a valuable tool for examining self-perceived health in young people over a broad range of ages.

Figure legends

Fig 1. Bars depict the percentage of “never” to “very often” responses to the question “How often/seldom do you feel stressed?” for 10- to 24-year-old females and males. The total number of respondents was 148 395. For the statistics, see the text.

Fig 2. Bars demonstrate the percentage of “never” and “very often” responses to the question “How often/seldom do you feel stressed?” divided by sex and age. The numbers in the graph represent the number of responding individuals. The statistics are reported in the text.

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