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Keywords:	self-esteem, self-rated health, psychological determinants, students, cohort study

Association between self-esteem and self-rated health among college students, the i-Share cohort

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ABBREVIATIONS

95%CI: 95% Confidential Interval

BMI: Body Mass Index

IQR: Interquartile range

MICE: Multivariate Imputation by Chained Equations

OR: Odds Ratio

p: p-value

ABSTRACT

Objectives: The aim of the study was to estimate the association between self-esteem and subsequent self-rated health during college years taking into account a wide range of potential confounders.

Methods: This study is based on the French cohort i-Share, a prospective population-based cohort study of students in higher education institutions in France. Eligibility criteria were to be officially enrolled at a university or higher education institute, to be at least 18 years of age, to be able to read and understand French and to provide informed consent for participation. We conducted multivariate modeling to evaluate the association between self-esteem levels and prospective assessment of self-rated health. Data regarding self-rated health, global self-esteem, and demographic, educational, social, behavioral, environmental and financial characteristics were collected through an internet-based questionnaire.

Results: The 1011 participants had a median age of 21.9 years and 79% (795/1011) were females. Self-rated health was assessed a median of 8 months after the self-esteem measurement. Twenty percent of the students declared average to very poor health (203/1011). Students with higher levels of self-esteem were more likely to declare good or very good self-rated health (adjusted odds ratio=1.40, 95% confidence interval [1.15-1.72], p-value=0.001). Other factors associated with good or very good self-rated health were low body mass index, a comfortable financial situation during childhood and three personality traits (low persistence and harm avoidance and high cooperativeness).

Conclusions: This study offers novel findings on the impact of self-esteem on self-rated health among college students. Interventions targeting self-esteem should be experimented during university years in order to improve health outcomes.

Keywords: self-esteem; self-rated health; psychological determinants; students; cohort study

ARTICLE SUMMARY

Strengths and limitations of this study

- The present study is based on a prospective design among a large number of participants
- A broad adjustment for confounders have been used to estimate unbiased association
- This study investigates self-rated health among college students, a population that has received less attention in the literature
- Participants were volunteers in the i-Share project which could have arisen a sampling bias. Extrapolation to other student populations may be limited.
- Reverse causation between self-esteem and self-rated health may exist and could not be investigated with our design.

AUTHORS CONTRIBUTIONS

J. Arsandaux and C. Galera developed the study concept and the study design. C. Tzourio is the principal investigator of the i-Share Cohort. M. Tournier and G. Michel participated actively in the creation of mental health questionnaire and bring psychological and psychiatric expertise to the interpretation of the results. J. Arsandaux performed the data analysis and interpretation under the supervision of C. Galera. J. Arsandaux drafted the manuscript, and all co-authors provided critical revisions. All authors approved the final version of the manuscript for submission.

INTRODUCTION

Self-rated health is considered to be a relevant indicator of general health. The high validity, reliability and predictive power of self-rated health make it one of the best predictors of objective health problems (including mortality) and health care utilization (1–3). Collection of self-rated health is recommended as a standard and cost-effective measure in health surveys (4–7). These associations persisted even after objective health adjustment, suggesting that self-rated health may represent a more inclusive and universal predictor than clinical examination, medical records or self-reports of medical conditions (8).

Determinants of self-rated health problems have attracted interdisciplinary interest. Several studies have investigated demographic, educational, social, behavioral, environmental and financial determinants (9). In addition, a few studies have emphasized the associations between psychosocial resources and self-rated health assessment (10,11). However, there are important pitfalls in the literature which should be underlined.

First, the population of college students has received little attention in this specific domain. Yet this period corresponding to the transition between adolescence and adulthood is crucial for the development of individuals, as well as for constructing and reinforcing self-esteem. Although the student population is in relatively good health, it is noteworthy that mental health and substance use issues are prevalent during the college years (12–14). On the one hand, self-rated health can serve to evaluate a general health status predicting future health problems before they set in. On the other hand, college is a period of development in which interventions could modify the onset of determinants such as psychosocial resources.

Second, despite recent research, psychosocial resources are insufficiently investigated in the literature (11). Among individual characteristics, the impact of self-esteem (i.e. the overall aggregated opinion of oneself at any one time, as defined by Rosenberg) on the rating of one's health remains poorly understood. To our knowledge, only two studies have estimated the association between self-esteem

and self-rated health, and none among college students (15,16). These studies have reported a significant relation supporting the hypothesis that high self-esteem is associated with better self-rated health. In addition, several studies have evidenced associations between self-esteem and several important outcomes related with health: academic success, well-being and internalized/externalized mental health problems (17,18). It should be noted that self-esteem is a potentially modifiable factor. Efficient interventions aiming at improving psychosocial abilities and self-knowledge are available (19,20).

A final limitation is the lack of studies that comprehensively adjust for various risk factors (i.e. the six domains reported above). This implies possible confounding biases that need to be addressed in order to identify a significant target for early public health interventions, such as self-esteem (9).

The aim of the present study was to estimate the association between self-esteem and subsequent self-rated health during college years, taking into account a wide range of potential confounders in the i-Share cohort. The i-Share cohort, one of the largest epidemiological studies conducted on European students, constitutes an opportunity to investigate this research question thanks to its large longitudinal collection of multidimensional data on childhood context, lifestyle, health information, living conditions and mental and psychosocial examinations.

METHODS

Study population

This study is based on the Internet-based Students Health Research Enterprise (i-Share, www.i-share.fr) project, a prospective population-based cohort study of students in higher education institutions in France. The objectives of i-Share cohort are to evaluate important health aspects among university students over the course of 10 years. Eligibility criteria are to be officially enrolled at a university or higher education institute, to be at least 18 years of age, to be able to read and understand French and to provide informed consent for participation. Recruitment started in February 2013.

Students were informed about the objectives of the study through promotion campaigns. Specifically, a group of trained students informed their peers about the study and initiate the online recruitment process. The baseline inquiry collected information on students' health, personal and family medical histories, socio-demographic characteristics, and lifestyle habits. Next, students received an e-mail invitation to complete follow-up questionnaires and sub-study data collection. Since December 2015, an optional mental health survey has been implemented to provide data on several dimensions of mental and psychological health. To date, the i-Share cohort is still ongoing. For this specific study, we used data available as of April 29th, 2016. We used a longitudinal design to compare self-esteem data collected during the mental health sub-study (Time 2) with the next planned assessment of self-rated health (i.e. during the 1st follow-up of the cohort, Time 3). We used baseline characteristics collected at cohort inclusion for adjustment (Time 1). Only college students aged between 18 and 30 years old, participating in the mental health sub-study before their 1st follow-up were included. The i-Share project on which this study was based was approved by the Commission Nationale de l'Informatique et des Libertés (CNIL) [DR-2013-019].

Participant involvement

No participant were involved in setting the research question or the outcome measures, nor were they involved in developing plans for design of the study. No participants were asked to advise on interpretation or writing up of results. However, there are plans to disseminate the results of the research to study participants by the use of the i-share website and social networks and by means of a newsletter send to participant quarterly via email. Furthermore, a group of trained students participated during the recruitment process (i.e. informed their peers about the study and initiate the online recruitment process). These students have been also involved during communication campaign, advising the study team about priority messages and communication tools.

Measures and scales

Outcome: Self-rated health

Students gauged their current general self-rated health by the question: "*Do you consider your current health?*" with a five-point response scale ranging from 1 to 5 (1="*Very poor*" / 2="*Poor*" / 3="*Average*" / 4="*Good*" / 5="*Very good*"). The variable was dichotomized as follows: "*Very good / Good*" versus "*Average / Poor / Very poor"*. Psychometric performance of this assessment has been reported in two papers (5,6). Self-rated health was measured at the participant's inclusion and during follow-up questionnaires. The 1st follow-up self-rated health measure corresponded to the primary outcome of this study (Time 3).

Main variable of interest: Self-esteem

Self-esteem was assessed using the Self-esteem scale (Rosenberg, 1965), a 10-item self-report measure of global self-esteem. Each item is answered on a 4-point Likert type scale ranging from 1="*Strongly disagree*" to 4="*Strongly agree*". The score can range from 10 (low level of self-esteem) to 40 (high level of self-esteem). The Rosenberg Self-esteem Scale is the most widely used instrument for the measurement of global self-esteem (21). It was translated into French, and its high reliability and validity were confirmed with a French sample (22). Self-esteem measurement was part of the optional mental health survey (Time 2). We used a continuous score for the primary analysis.

Covariates

All the covariates were collected through the self-administered online questionnaire at cohort enrolment (Time 1), except for psychosocial covariates which are part of the mental health sub-study (i.e. same time as self-esteem measurement, Time 2). Covariates included in this study covered the 6 domains of potential determinants of self-rated health described in the literature (9):

Demographic covariates: We built the following demographic variables: *sex* (male/female), *age* (in years when the outcome was measured, Time 3) and *Body Mass Index (BMI) (*<25 vs >=25 kg/m²).

Academic covariates: Education level of student was collected at cohort inclusion and categorized into: freshman, sophomore, junior and senior. For *parental education level*, we used the declared

education level of parents by students (at least one of their parents had a higher education level than baccalaureate versus not).

Financial covariates: Self-rated economic situation during childhood ("*Very difficult"/"Difficult"/"Correct"* versus *"Comfortable"/"Very comfortable*") and s*elf-rated satisfaction about financial resources during college* ("*Very satisfied"/"Rather satisfied"* versus *"Satisfied"/"Rather dissatisfied"/"Totally unsatisfied*").

Social covariates: Students *living conditions* (cohabitation with parents, flatsharing/couple or alone) and *self-rated familial support during childhood* (Weak "*None at all*"/ "*A little*"/"*Moderate*" versus High "*A lot*"/"*Enormous*").

Geographical covariates: Students included in this study were spread over the French territory. To take into account disparities across college campuses we selected the 4 most constitutive *cities of the registration university* in the sample (Bordeaux/Versailles/Nice/Paris/other).

Behavioral covariates: Tobacco consumption (none, ≤10 cigarettes/day, >10 cigarettes/day). *Binge drinking frequency* was defined as drinking at least 6 drinks on the same occasion (evening) (Never, Rarely if "*Once a year*", Occasionally if "*several times a year*"/"*once a month*", Frequently if "*once a week or less*"/"*2 to 3 times a week*"/"*4 to 6 times a week*"). Then students declared whether at least once in life they consumed *psychoactive substances* from cannabis, ecstasy, amphetamines, nitrous oxide, inhalation products and cocaine. To determine *physical activity frequency*, we combined walking times and sports by summing the count number of duration in minutes per day (<25, between 25 to 35, >35). Finally, good nutritional habits was based on adherence to The French National Nutrition and Health Program (PNNS) (23). Each of the seven nutrition recommendation was coded 0 if not followed and 1 if followed. The sum (7 representing the highest adherence to recommendations and 0 the lowest) was computed.

Psychosocial covariates: Coping was measured by the Student Coping Scale (24). Three sub-scores are computed representing social support coping, emotional coping and festive coping (higher score

represented higher coping resources). *Aggressiveness* was measured by an adaptation of the Brown-Goodwin assessment for Life History of Aggression, translated into French by Bellivier (25). Higher scores represented higher aggressiveness. *Impulsivity* was measured by an Adolescent Version of the Barratt Impulsiveness Scale-11 (BIS-11-A) translated into French by Coudrey F. and Michel G (26). Higher score represent higher impulsivity. *Personality traits* were measured by the Temperament and Character Inventory translated into French by Pélissolo F (27,28). Six sub-scores were computed: novelty seeking, persistence, harm avoidance, determination, reward dependence and cooperativeness. Higher scores represented higher adherence to the type of personality.

Objective health indicator: participants with at least one medical diagnosis for mental or physical diseases or disability at cohort inclusion.

Study size

We performed a sample size calculation for logistic regression between self-esteem and self-rated health, alpha 0.05 and power 0.90. Based on two French studies among college students, we assumed that the distribution of self-esteem was normal (mean=28.9, standard deviation=5.7) (29,30). The proportion of participants who declare having good or very good health has been estimated in 2 studies in Sweden and Italy among college students to be 13 and 23% respectively (31,32). We assumed the odds ratio (OR) to be 1.1 based on the only two studies reported among high school students in South Korea and adults in Canada (15,16). The minimum sample size required was between 232 and 344 depending on self-rated health proportions (SAS software PROC POWER).

Statistical analysis

First we described the study sample. Then, in order to estimate the association between self-esteem and self-rated health, we computed a logistic regression model. We modeled the probability of declaring good or very good self-rated health during the 1st follow-up. The primary explanatory variable was self-esteem. To allow relevant interpretation, we estimate associations for the increase of one standard deviation (i.e. 5.696). All the potential confounders described above were entered in the

model as covariates. In the modeling process, we first estimated univariate models. Log-linearity of the effect of self-esteem (continuous variable) was checked. We tested interactions for gender, age and cities among self-rated health and self-esteem links by univariate models and performed stratified analysis if the interaction was significant ($p<0.05$). Then we selected variables if p-value<0.25 to compute multivariate models. Finally, we performed a stepwise backward selection for a final multivariate model with a threshold of p-value=0.05. At every step, we checked the confusion effect and computed the OR, 95% confidential interval (95%CI) and p-value (p) of the corresponding Wald test.

Finally we conducted sensitivity analyses to test the robustness of the findings: (1) modeling self-rated health (a) in continuous variable (ranging from 1 to 5) and (b) in three categories (with an "average" modality); (2) estimating the self-esteem effect throughout a categorized variable (corresponding to quartiles: <=25,]25-28],]28-33], >33) to bring to light a potential dose-response effect; (3) completing the adjustment (a) with baseline self-rated health; (b) forcing the adjustment with delays between the three measurement periods; (c) with objective health indicator; (4) performing primary modeling among the complete case population.

Our missing data analysis procedures used missing at random (MAR) assumptions. We used the MICE (multivariate imputation by chained equations) method of multiple multivariate imputation in SAS software (PROC MI and MIANALYZE) (33,34). We independently analyzed 10 copies of the data, each with missing values suitably imputed, in the multivariate logistic regression analyses. We averaged estimates of the variables to give a single mean estimate and adjusted standard errors according to Rubin's rules. We imputed only data from covariates using self-esteem, self-rated health, covariates data and completed imputation process with other data collected in the i-share cohort (alcohol consumption, walking time per day, time of sport practice, stress score, anxiety score, depression score and self-rated quality of sleep).

We performed all analyses using the SAS statistical software (SAS version 9.3; SAS Institute Inc, Cary, NC).

RESULTS

The total sample comprised 1011 participants. Figure 1 shows the flow chart of the study population. Of the 14795 college students enrolled in the i-Share cohort, 3613 completed the mental health sub-study, 1038 were eligible for this study and 1011 were ultimately analyzed. Prospective self-rated health assessment (i.e. during the 1st follow-up, Time 3) occurred between 1 and 3 years after inclusion in the cohort (Median=13.2 months) and between 1 month and 3 years after completion of the mental health sub-study (i.e. self-esteem measure, Time 2) (Median=8.4 months). Baseline characteristics of the study population are presented in Table 1. The median age of participants was 21.9 (Interquartile range (IQR)=20.2-23.7) years, 795/1011 (79%) were female, 367/1011 (37%) were freshmen and most students were in Bordeaux (686/1011, 68%). 346/1011 (34%) participants had at least one missing data item among covariates. BMI and living situation were the most frequently missing variables (15% and 12% respectively) and other missing variables accounted for less than 5% of missing data. At inclusion, 18% of the students declared average or poor health (183/1011). At 1st follow-up, 20% of the students declared average or poor health (203/1011).

Self-esteem among students who declared average or poor health at 1st follow-up was lower than students who declared good or very good health (mean=26.2, 95%CI [25.4-27.0] versus mean=28.1, 95%CI [28.8-29.5], p<0.0001). Table 2 presents the whole modeling process after imputation of missing data. The unadjusted self-esteem effect (for the increase of one standard deviation) on self-rated health was statistically significant (OR=1.70, 95%CI [1.44-1.99], p<0.0001). Log-linearity of the self-esteem effect was confirmed, allowing a valid estimation. All predefined interactions (gender, cities and age) were not statistically significant (all p-values >0.10). The final multivariate model was adjusted for BMI, financial situation during childhood and 3 personality traits (persistence, harm avoidance and cooperativeness). With this final model, the increase of one standard deviation of self-esteem was associated with a 40% increase in the probability of declaring good or very good health versus average to very poor health (adjusted OR=1.40, 95%CI [1.15-1.72], p=0.001).

BMI>25 kg/m², difficult financial situation during childhood decreased by 2 the probability of declaring good to very good health. Three personality traits were associated with self-rated health: low persistence and harm avoidance and high cooperativeness were associated with declaring good to very good health. The restraint model showed acceptable discrimination power (Area Under Curve=0.7205) and the Hosmer-Lemeshow test proved model suitability to data (p-value=0.8614).

Table 3 presents sensitivity analysis results showing the robustness of findings. Whatever the modeling choices for self-rated health and self-esteem or adjusting strategies, higher self-esteem was persistently associated with better self-rated health. Furthermore, the model with self-esteem in four categories showed a dose-response effect with graduate adjusted OR and a significant global test ($p<0.04$).

DISCUSSION

Findings of study

In this large longitudinal study among college students, higher self-esteem levels were independently associated with better self-rated health, even after complete adjustment for known confounders. This association was not modified by gender or age. Additional risk factors such as BMI, financial situation during childhood and personality traits (persistence, harm avoidance and cooperativeness) were associated with self-rated health. This original finding opens up an opportunity for interventional research targeting psychosocial resources, especially self-esteem, in the university setting.

Interpretation

The association between higher levels of self-esteem and better self-rated health found in the current study corroborates previous research. This finding based on a sample of college students, supports and extends previous studies on other population samples by showing the same pattern of association between self-esteem and self-rated health (15,16). Several research works and literature reviews formulate hypotheses on the potential underlying mechanisms which could explain the relationship between self-esteem and health. Good self-esteem may enable individuals to make better choices,

including adopting healthy behaviors (18). High self-esteem may increase the ability to put in place appropriate strategies to cope with everyday situations, which in turn increases the capacity to feel well and more generally the capacity of resilience (35). An alternative hypothesis is based on bodily sensations (i.e. information that conveys messages from the organism to the brain). This information is available to the individual consciousness, is included in self-rating of health and may reflect important physiological dysregulations, such as inflammatory processes (36). In this hypothesis, self-esteem appears to be a psychosocial ability that allows individuals to better cope with stress and prevents or diminishes these deleterious inflammatory processes. Throughout the literature, several determinants of self-rated health have been found (9). Consistently, we found in our study that a low BMI, a comfortable financial situation during childhood and three personality traits were associated with good self-rated health. In contrast to the literature, we have not found gender differences for self-rated health after complete adjustment (37–39). This discordant result could be due to differences in sampling and adjustment strategies. In particular, fewer males than women participated in the i-Share cohort. Moreover, we found that self-rated health was influenced more by the family's financial difficulties during childhood than during college years.

Strengths and limitations

The strengths of our study include the large number of participants, the longitudinal design, the standardized assessment tools and the broad adjustment for confounders. In addition, this study investigates self-rated health among college students, a population that has received less attention in the literature. A set of limitations should however be considered to properly interpret the findings. First, a sampling bias could have arisen since participants were volunteers in the i-Share project and we selected participants who have data on the first follow-up, extrapolation to other student populations may be limited. Second, we used a longitudinal design with a median follow-up period of 8 months, which is relevant to assess impact on self-rated health in young adults. But we do not have any information on persistency of the self-esteem/self-rated health relationship in the longer term, especially after the academic years. Moreover, reverse causation between self-esteem and self-rated

health may exist and could not be investigated with our design. However, in sensitivity analyses, when self-rated health measurement prior to self-esteem was entered in the model as a covariate, the result remained similar. Further research should use repeated self-esteem and self-rated health measurements to better explore the bidirectionality assumption.

Implications

From a public health perspective this study provides a contributive insight for interventional research. It suggests that interventions targeting self-esteem during college years should be experimented. Yet the type of intervention is still to be determined since most of the previous interventional research on self-esteem has concerned children (19,20). Consequently, further studies are needed to investigate whether these interventions could be extended or transferred to college students. Additionally, information about multidimensional self-esteem could support the choice of an intervention in the broad spectrum existing among children. Self-esteem improvement interventions could focus either on (1) global self-esteem by increasing self-knowledge and resilience through an individual intervention, web-based for instance, or (2) a specific dimension such as social self-esteem by using exercise or mentoring program (19,20). Further, the university years represent a relevant period for implementing early interventions, before health behaviors and mental health problems set in. College setting offers a positive climate for learning, a structured organization, the availability of mentoring and physical activity programs.

From a research perspective, we have identified two priority areas. First, it appears necessary to better understand the pathways between self-esteem and self-rated health conducting mediational analyses. Second, the self-reported nature of the 2 measures (i.e. self-esteem and self-rated health) might explain why they are linked (36). Considering that self-esteem has been reported to be linked with health outcomes other than self-rated health, we believe that associations with both the evaluation framework and health are coexisting.

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CONFLICTS OF INTEREST

None declared

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Tables

Table 1. Characteristics of the study population concerning outcome (i.e. self-rated health), main exposure variable (i.e. self-esteem) and demographic data at Time 1: cohort enrolment, Time 2: optional mental health survey, Time 3: cohort follow-up in the i-Share Cohort, France, 2013-2016. n=1011

Characteristics	Participants n=1011	
Outcome at Time 3		
SRH 5-items, n (%)		
Very good	225	(22.3)
Good	583	(57.7)
Average	177	(17.5)
Poor	26	(2.6)
Very poor	0	(-)
SRH dichotomized, n (%)		
Very good to good	808	(79.9)
Average to very poor	203	(20.1)
SRH in continuous[a], median (IQR)	2.0	(2.0 ; 2.0)
Main exposure at Time 2		
Self-esteem in continuous variable, median (IQR)	28	(25 ; 33)
Self-esteem in categorical variable, n (%)		
≤25	287	(28.4)
]25-28]	219	(21.7)
]28-33]	277	(27.4)
>=33	228	(22.6)
Demographic data		

Age at Time 3, median (IQR)	21.9	(20.2 ; 23.7)
Female, n (%)	795	(78.6)
BMI <25 Kg/m² at Time 1, n (%)	909	(89.9)

n: number of participants; IQR: Interquartile Range; BMI: Body Mass Index ; SRH: self-rated health

[a] *1=Very good, 2=Good, 3=Average, 4=Poor, 5=Very poor*

Table 2. Final logistic model of probability to declare good or very good compared to very poor, poor or average self-rated health after imputation of missing data on covariates. The i-Share Cohort, France, 2013-2016. n=1011

	Self-rated health[a], n(%) or median (IQR)		**Multivariate model**	
	Good / very good, n=808	Average / poor, n=203	aOR	95%CI
Self-esteem (for the increase of one standard deviation[b])	29 (26-33)	26 (22-30)	1.40	1.15 ; 1.72***
BMI at inclusion				
<25 kg/m²	623 (89.6)	130 (81.3)	1	-
>=25	72 (10.4)	30 (18.8)	0.50	0.31 ; 0.80***
Financial situation during childhood				
Comfortable to very comfortable	487 (60.3)	86 (42.4)	1	-
Correct to very difficult	321 (39.7)	117 (57.6)	0.54	0.39 ; 0.74***
Personality				
Persistence	29 (24-31)	29 (25-33)	0.94	0.91 ; 0.97***
Harm avoidance	26 (22-30)	29 (25-33)	0.95	0.92 ; 0.98***
Cooperativeness	32 (29-35)	32 (28-35)	1.04	1.01 ; 1.08**

n: number of participants; IQR: Interquartile Range; BMI: Body Mass Index; OR: Odds Ratio; 95%CI: 95% Confidence Interval

[a] Self-rated health description provided before data-imputation

[b] Self-esteem standard deviation: 5.696

*p-value<0.25; **p-value<0.05; ***p-value<0.01

Table 3. Sensitivity analysis of the effect of self-esteem on self-rated health. The i-Share Cohort, France, 2013-2016. n=1011

	Estimation[a] of increase of one standard deviation[b] for (1), (3) and (4) and natural scale for (2) of self-esteem effect on self-rated health
(1) modeling self-rated health	
(a) in continuous variable (ranging from 1 to 5)[c]	β=-0.05 p=0.0005
(b) in three categories (with a "average" modality)	
Average versus Poor/very poor	OR=1.69 p =0.0429
Good/very good versus Poor/very poor	OR=2.23 p =0.0015
(2) estimating self-esteem effect throughout a categorized variable	
]25-28] vs ≤25	OR=1.25 p=0.3032
]28-33] vs ≤25	OR=2.28 p=0.0009
>33 vs ≤25	OR=1.85 p=0.0301
(3) completing adjustment	
(a) with baseline self-rated health	OR=1.29 p=0.0160
(b) forcing the adjustment with delays between the three measurement periods	OR=1.40 p=0.0009
(c) with objective health indicator	OR=1.40 p=0.0011
(4) performing primary modeling among complete case population (n=665)	OR=1.55 p=0.0009

OR: Odds Ratio; p: p-value

[a] *Models adjusted for Body Mass Index, financial situation during childhood, personality scores (persistence, harm avoidance, cooperativeness)*

[b] *Self-esteem standard deviation: 5.696*

[c] *High score represent better self-rated health*

Figures

Figure 1. Flow diagram showing participant flow through the study based on the i-Share Cohort, France, 2013-2016.

Supplementary material

Table S1. Characteristics of the study population concerning educational, financial, social, geographical, follow up, behavioral and psychological data at Time 1: cohort enrolment, Time 2: optional mental health survey, Time 3: cohort follow-up in the i-Share Cohort, France, 2013-2016. n=1011

Table S2. Univariate and multivariate logistic model of probability to declare good or very good compared to very poor, poor or average self-rated health after imputation of missing data on covariates. The i-Share Cohort, France, 2013-2016. n=1011

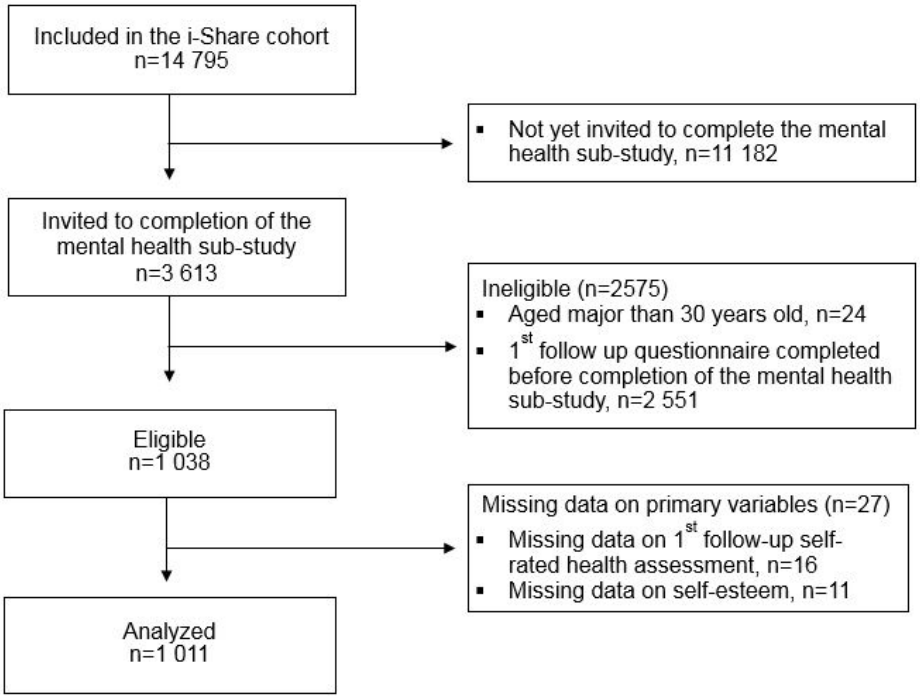

Figure 1. Flow diagram showing participant flow through the study based on the i-Share Cohort, France, 2013-2016.

187x134mm (96 x 96 DPI)

Table S1. Characteristics of the study population concerning educational, financial, social, geographical, follow up, behavioral and psychological data at Time 1: cohort enrolment, Time 2: optional mental health survey, Time 3: cohort follow-up in the i-Share Cohort, France, 2013-2016. n=1011

Characteristics	Participants n=1011	
Educational data at Time 1, n (%)		
University year		
Freshman	367	(36.5)
Sophomore	218	(21.7)
Junior	154	(15.3)
Senior	267	(26.5)
At least one parent with high education level	274	(28.5)
Financial data at Time 1, n (%)		
Comfortable to very comfortable financial situation during childhood	573	(56.7)
Rather satisfied to very satisfied with financial resources	504	(49.8)
Social data at Time 1, n (%)		
Cohabitation		
With parents	278	(31.3)
Flatsharing or couple	287	(32.4)
No cohabitation / alone	322	(36.3)
Strong familial support during childhood	730	(72.9)
Geographical and follow-up data		
City of the registration university at Time 1, n (%)		
Bordeaux	686	(67.9)
Versailles	77	(7.6)
Nice	22	(2.2)
Paris	45	(4.5)
Other	181	(17.9)
Delay in months between inclusion and SRH assessment (follow-up), median (IQR)	13.2	(12.3 ; 23.4)
Delay in months between mental health assessment and SRH assessment (follow-up), median (IQR)	8.4	(3.2 ; 12.0)
Behavioral data at Time 1		
Tobacco consumption, n (%)		
None	761	(75.3)
<=10 cigarettes	213	(21.1)
>10 cigarettes	37	(3.66)
Alcohol consumption frequency during evening, n (%) (MD=40/1)		
Never	22	(2.3)
Rarely	225	(23.2)
Occasionally	393	(40.5)
Frequently	330	(34.0)
Psychoactive substance consumption at least once in life, n (%)	603	(59.6)
Accordance with nutritional French recommendations, median (IQR)	3	(3 ; 4)
Physical activity, n (%)		
Less than 25 min/day	109	(10.9)
Between 25 and 35 min/day	183	(18.3)
More than 35 min/day	706	(70.7)
Psychological data at Time 2, median (IQR)		
Coping - Social support	11	(8 ; 14)
Coping - Emotional	20	(17 ; 22)
Coping - Festive-addictive	11	(9 ; 14)
Impulsivity	61	(56 ; 67)

Aggressiveness	1	(0 ; 3)
Personality - Novelty seeking	20.5	(18 ; 23)
Personality - Persistence	28	(24 ; 31)
Personality - Harm avoidance	27	(22 ; 31)
Personality - Determination	27	(23 ; 31)
Personality - Reward dependence	28	(23 ; 32)
Personality - Cooperativeness	32	(29 ; 35)

n: number of participants; IQR: Interquartile Range; BMI: Body Mass Index ; SRH: self-rated health

Table 1 supp mat. Univariate and multivariate logistic model of probability to declare good or very good compared to very poor, poor or average self-rated health after imputation of missing data on covariates. The i-Share Cohort, France, 2013-2016. n=1011

	Univariate model		Multivariate model	
	OR	95%CI	aOR	95%CI
MAIN EXPOSURE				
Self-esteem (for the increase of one standard deviation[b])	1.70	1.44 ; 1.99***	1.40	1.15 ; 1.72***
COVARIATES				
Demographic data				
Gender				
Male	1	-		
Female	0.48	0.31 ; 0.74***		
Age at self-rated health assessment (follow-up)	0.98	0.92 ; 1.04		
BMI at inclusion				
<25 kg/m²	1	-	1	-
>=25	0.52	0.33 ; 0.81***	0.50	0.31 ; 0.80***
Educational data				
University year at inclusion		*		
1st year / freshman	1	-		
2nd year / sophomore	1.54	1.00 ; 2.37		
3rd year / junior	1.60	0.98 ; 2.62		
4th year or more / senior	1.22	0.83 ; 1.80		
Parents' education level				
At least one with high level	1	-		
Both with low level or only one given with low level	0.86	0.60 ; 1.22		
Financial data				
Financial situation during childhood				
Comfortable to very comfortable	1	-	1	-
Correct to very difficult	0.48	0.36 ; 0.66***	0.54	0.39 ; 0.74***
Satisfaction with financial resources at inclusion				
Rather satisfied to very satisfied	1	-		
Completely dissatisfied to satisfied	0.55	0.40 ; 0.75***		
Social data				
Cohabitation at inclusion				
No cohabitation	1	-		
With parents	1.03	0.70 ; 1.51		
Flat sharing or couple	1.12	0.76 ; 1.64		
Familial support during childhood				
Strong	1	-		
Weak	0.56	0.40 ; 0.78***		
Geographical and follow-up data				
City of the registration university				
Bordeaux	1	-		
Versailles	1.16	0.63 ; 2.14		
Nice	1.16	0.39 ; 3.49		
Paris	1.04	0.49 ; 2.20		
Other	1.08	0.71 ; 1.63		
Delay in months between inclusion and self-rated health assessment (follow-up)	1.00	0.97 ; 1.03		
Delay in months between mental health assessment and self-rated health assessment (follow-up)	1.00	0.98 ; 1.02		
Behavioral data				

Tobacco consumption at inclusion				
None	1	-		
<=10 cigarettes	0.97	0.66 ; 1.42		
>10 cigarettes	0.66	0.31 ; 1.40		
Alcohol consumption frequency during evening at inclusion		**		
Never drink	1	-		
Never binge	1.09	0.41 ; 2.91		
Occasionally binge	1.53	0.58 ; 4.05		
Frequently binge	1.99	0.75 ; 5.33		
Psychoactive substance consumption				
Never	1	-		
Once in life	1.26	0.92 ; 1.72*		
Accordance with nutritional French recommendations	0.97	0.85 ; 1.10		
Physical activity				
More than 35 min/day	1	-		
Less than 25 min/day	0.89	0.54 ; 1.44		
Between 25 and 35 min/day	1.01	0.67 ; 1.52		
Psychological data				
Coping				
Social support	1.03	0.99 ; 1.08*		
Emotional	0.93	0.90 ; 0.97***		
Festive-addictive	1.04	1.00 ; 1.09*		
Impulsivity	0.99	0.97 ; 1.01*		
Agressiveness	0.95	0.90 ; 1.00**		
Personality				
Novelty seeking	1.02	1.00 ; 1.06*		
Persistence	0.95	0.92 ; 0.97***	0.94	0.91 ; 0.97***
Harm avoidance	0.91	0.89 ; 0.94***	0.95	0.92 ; 0.98***
Determination	1.07	1.04 ; 1.10***		
Reward dependence	1.03	1.01 ; 1.06**		
Cooperativeness	1.04	1.01 ; 1.08***	1.04	1.01 ; 1.08**

n: number of participants; IQR: Interquartile Range; BMI: Body Mass Index; OR: Odds Ratio; 95%CI: 95% Confidence Interval

[a] Self-rated health description provided before data-imputation

[b] Self-esteem standard deviation: 5.696

*p-value<0.25; **p-value<0.05; ***p-value<0.01

STROBE 2007 (v4) checklist of items to be included in reports of observational studies in epidemiology*
Checklist for cohort, case-control, and cross-sectional studies (combined)

Section/Topic	Item #	Recommendation	Reported on page #
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1,3
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	3
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	5,6
Objectives	3	State specific objectives, including any pre-specified hypotheses	6
Methods			
Study design	4	Present key elements of study design early in the paper	7
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	6,7
Participants	6	(*a*) *Cohort study*—Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up *Case-control study*—Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls *Cross-sectional study*—Give the eligibility criteria, and the sources and methods of selection of participants	6,7
		(*b*) *Cohort study*—For matched studies, give matching criteria and number of exposed and unexposed *Case-control study*—For matched studies, give matching criteria and the number of controls per case	NA
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	7,8,9,10
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	*7,8,9,10*
Bias	9	Describe any efforts to address potential sources of bias	8,10,11
Study size	10	Explain how the study size was arrived at	10
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	7,8,9,10
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	10,11
		(*b*) Describe any methods used to examine subgroups and interactions	10,11
		(*c*) Explain how missing data were addressed	11
		(*d*) *Cohort study*—If applicable, explain how loss to follow-up was addressed *Case-control study*—If applicable, explain how matching of cases and controls was addressed *Cross-sectional study*—If applicable, describe analytical methods taking account of sampling strategy	14
		(*e*) Describe any sensitivity analyses	11
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	11,12
		(b) Give reasons for non-participation at each stage	Figure 1

		(c) Consider use of a flow diagram	Figure 1
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	12 + Table 1 + Table 1 supp
		(b) Indicate number of participants with missing data for each variable of interest	12
		(c) *Cohort study*—Summarise follow-up time (eg, average and total amount)	12
Outcome data	15*	*Cohort study*—Report numbers of outcome events or summary measures over time	12 + Table 1
		Case-control study—Report numbers in each exposure category, or summary measures of exposure	
		Cross-sectional study—Report numbers of outcome events or summary measures	
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	12 + Table 2
		(*b*) Report category boundaries when continuous variables were categorized	
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	13 + Table 3
Discussion			
Key results	18	Summarise key results with reference to study objectives	13
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	14
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	13,14
Generalisability	21	Discuss the generalisability (external validity) of the study results	15
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	16

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

BMJ Open

Is self-esteem associated with self-rated health among French college students? An epidemiological longitudinal study, the i-Share cohort

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Is self-esteem associated with self-rated health among French college students? An epidemiological longitudinal study, the i-Share cohort

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ABBREVIATIONS

95%CI: 95% Confidential Interval

BMI: Body Mass Index

IQR: Interquartile range

MICE: Multivariate Imputation by Chained Equations

OR: Odds Ratio

p: p-value

ABSTRACT

Objectives: The aim of the study was to estimate the association between self-esteem and subsequent self-rated health during college years taking into account a wide range of potential confounders.

Design: Prospective longitudinal study.

Setting: The French i-Share cohort.

Participants: The sample consisted of 1011 college students.

Primary and secondary outcome measures: The association between self-esteem and later self-rated health was evaluated using multivariate modeling.

Data regarding self-rated health, global self-esteem, and demographic, educational, social, behavioral, environmental and financial characteristics were collected through an internet-based questionnaire.

Results: The 1011 participants had a median age of 21.9 years and 79% (795/1011) were females. Self-rated health was assessed a median of 8 months after the self-esteem measurement. Twenty percent of the students declared average to very poor health (203/1011). Students with higher levels of self-esteem were more likely to declare good or very good self-rated health (adjusted odds ratio=1.40, 95% confidence interval [1.15-1.72], p-value=0.001). Other factors associated with good or very good self-rated health were low body mass index, a comfortable financial situation during childhood and three personality traits (low persistence and harm avoidance and high cooperativeness).

Conclusions: This study offers novel findings on the impact of self-esteem on self-rated health among college students. Interventions targeting self-esteem should be experimented during university years in order to improve health outcomes.

Keywords: self-esteem; self-rated health; psychological determinants; students; cohort study

ARTICLE SUMMARY

Strengths and limitations of this study

- The present study is based on a prospective design among a large number of participants
- A broad adjustment for confounders have been used to estimate unbiased association
- This study investigates self-rated health among college students, a population that has received less attention in the literature
- Participants were volunteers in the i-Share project which could have arisen a sampling bias. Extrapolation to other student populations may be limited.
- Reverse causation between self-esteem and self-rated health may exist and could not be investigated with our design.

AUTHORS CONTRIBUTIONS

J. Arsandaux and C. Galera developed the study concept and the study design. C. Tzourio is the principal investigator of the i-Share Cohort. M. Tournier and G. Michel participated actively in the creation of mental health questionnaire and bring psychological and psychiatric expertise to the interpretation of the results. J. Arsandaux performed the data analysis and interpretation under the supervision of C. Galera. J. Arsandaux drafted the manuscript, and all co-authors provided critical revisions. All authors approved the final version of the manuscript for submission.

DATA AVAILABILITY

The scientific comitee of the i-share cohort can be conTacted for deidentified participant data transfert.

INTRODUCTION

Self-rated health is considered to be a relevant indicator of general health. The high validity, reliability and predictive power of self-rated health make it one of the best predictors of objective health problems (including mortality) and health care utilization (1–6) Collection of self-rated health is recommended by the World Health Organization (WHO) as a standard and cost-effective measure in health surveys (7–10)

. The associations between self-rated health and mortality persisted even after objective health adjustment, suggesting that self-rated health could represent an inclusive and universal predictor besides clinical examination, medical records or self-reports of medical conditions (11).

Determinants of self-rated health problems have attracted interdisciplinary interest. Several studies have investigated demographic, educational, social, behavioral, environmental and financial determinants (12). In addition, a few studies have emphasized the associations between psychosocial resources and self-rated health assessment (13,14). However, there are important limitations in the literature which should be underlined.

First, despite recent research, psychosocial resources are insufficiently investigated in the literature (14). Among individual characteristics, the impact of self-esteem (i.e. the overall aggregated opinion of oneself at any one time, as defined by Rosenberg) on the rating of one's health remains poorly understood. Yet, it should be noted that self-esteem is a potentially modifiable factor. If self-esteem is predictive of self-rated health independently of other psychosocial confounders it could then represent a specific target for preventive interventions aiming at improving general health. Interestingly efficient interventions focusing on psychosocial abilities and self-knowledge provide relevant tools to experiment such specific interventions on self-esteem (15,16). To our knowledge, only two studies have estimated the association between self-esteem and self-rated health, and none among college students (17,1). These studies have reported a significant relation supporting the hypothesis that high self-esteem is associated with better self-rated health. In addition, several studies have evidenced

associations between self-esteem and several important outcomes related with health: academic success, well-being and internalized/externalized mental health problems (18,19).

Second, the population of college students has received little attention in this specific domain. Yet this period corresponding to the transition between adolescence and adulthood is crucial for the development of individuals, as well as for constructing and reinforcing self-esteem. Although the student population is in relatively good health, it is noteworthy that mental health and substance use issues are prevalent during the college years (20–22). On the one hand, self-rated health can serve to evaluate a general health status predicting future health problems before they set in. On the other hand, college is a period of development in which interventions could modify the onset of determinants such as psychosocial resources

A final limitation is the lack of studies that comprehensively adjust for various risk factors (i.e. the six domains reported above). This implies possible confounding biases that need to be addressed in order to identify a significant target for early public health interventions, such as self-esteem (12).

The aim of the present study was to estimate the association between self-esteem and subsequent self-rated health during college years, taking into account a wide range of potential confounders in the i-Share cohort.

METHODS

Study population

This study is based on the Internet-based Students Health Research Enterprise (i-Share, www.i-share.fr) project, a prospective population-based cohort study of students in higher education institutions in France. . The i-Share cohort, one of the largest epidemiological studies conducted on European students, constitutes an opportunity to investigate this research question thanks to its large longitudinal collection of multidimensional data on childhood context, lifestyle, health information,

living conditions and mental and psychosocial examinations(23,24). The objectives of i-Share cohort are to evaluate important health aspects among university students over the course of 10 years. Eligibility criteria are to be officially enrolled at a university or higher education institute, to be at least 18 years of age, to be able to read and understand French and to provide informed consent for participation. Recruitment started in February 2013. Students were informed about the objectives of the study through promotion campaigns. Specifically, a group of trained students informed their peers about the study and initiate the online recruitment process. The baseline inquiry collected information on students' health, personal and family medical histories, socio-demographic characteristics, and lifestyle habits. Next, students received an e-mail invitation to complete follow-up questionnaires and sub-study data collection. As of February 6, 2016, 14 795 participants were included in the cohort, there are 21 year old in mean, 74% are female and the response rate for one-year follow-up is 6%. Since December 2015, an optional mental health survey has been implemented to provide data on several dimensions of mental and psychological health. To date, the i-Share cohort is still ongoing. For this specific study, we used data available as of April 29th, 2016. We used a longitudinal design to compare self-esteem data collected during the mental health sub-study (Time 2) with the next planned assessment of self-rated health (i.e. during the 1st follow-up of the cohort, Time 3). We used baseline characteristics collected at cohort inclusion for adjustment (Time 1). Figure S1 describes the study timeline in supplementary material. Only college students aged between 18 and 30 years old, participating in the mental health sub-study before their 1st follow-up were included. The i-Share project on which this study was based was approved by the Commission Nationale de l'Informatique et des Libertés (CNIL) [DR-2013-019].

'Patient and Public Involvement'

No participant were involved in setting the research question or the outcome measures, nor were they involved in developing plans for design of the study. No participants were asked to advise on interpretation or writing up of results. However, there are plans to disseminate the results of the research to study participants by the use of the i-share website and social networks and by means of a

newsletter send to participant quarterly via email. Furthermore, a group of trained students participated during the recruitment process (i.e. informed their peers about the study and initiate the online recruitment process). These students have been also involved during communication campaign, advising the study team about priority messages and communication tools.

Measures and scales

Outcome: Self-rated health

Students gauged their current general self-rated health by the question: "*Do you consider your current health?*" with a five-point response scale ranging from 1 to 5 (1="*Very poor*" / 2="*Poor*" / 3="*Average*" / 4="*Good*" / 5="*Very good*"). The variable was dichotomized as follows: "*Very good / Good*" versus "*Average / Poor / Very poor"*. Psychometric performance of this assessment has been reported in two papers (8,9). Self-rated health was measured at the participant's inclusion and during follow-up questionnaires. The 1st follow-up self-rated health measure corresponded to the primary outcome of this study (Time 3).

Main variable of interest: Self-esteem

Self-esteem was assessed using the Self-esteem scale (Rosenberg, 1965), a 10-item self-report measure of global self-esteem. Each item is answered on a 4-point Likert type scale ranging from 1="*Strongly disagree*" to 4="*Strongly agree*". The score can range from 10 (low level of self-esteem) to 40 (high level of self-esteem). The Rosenberg Self-esteem Scale is the most widely used instrument for the measurement of global self-esteem (25). It was translated into French, and its high reliability and validity were confirmed with a French sample (26). Self-esteem measurement was part of the optional mental health survey (Time 2). We used a continuous score for the primary analysis.

Covariates

All the covariates were collected through the self-administered online questionnaire at cohort enrolment (Time 1), except for psychosocial covariates which are part of the mental health sub-study (i.e. same time as self-esteem measurement, Time 2). They were all preceding the outcome to keep the

longitudinal sequence between predictors and outcome. Covariates included in this study covered the 6 domains of potential determinants of self-rated health described in the literature (12):

Demographic covariates: We built the following demographic variables: *sex* (male/female), *age* (in years when the outcome was measured, Time 3).

Academic covariates: Education level of student was collected at cohort inclusion and categorized into: freshman, sophomore, junior and senior. For *parental education level*, we used the declared education level of parents by students (at least one of their parents had a higher education level than baccalaureate versus not).

Financial covariates: Self-rated economic situation during childhood ("*Very difficult"/"Difficult"/"Correct"* versus *"Comfortable"/"Very comfortable*") and s*elf-rated satisfaction about financial resources during college* ("*Very satisfied"/"Rather satisfied"* versus *"Satisfied"/"Rather dissatisfied"/"Totally unsatisfied*").

Social covariates: Students *living conditions* (cohabitation with parents, flatsharing/couple or alone) and *self-rated familial support during childhood* (Weak "*None at all*"/ "*A little*"/"*Moderate*" versus High "*A lot*"/"*Enormous*").

Geographical covariates: Students included in this study were spread over the French territory. To take into account disparities across college campuses we selected the 4 most constitutive *cities of the registration university* in the sample (Bordeaux/Versailles/Nice/Paris/other).

Behavioral covariates: Tobacco consumption (none, ≤10 cigarettes/day, >10 cigarettes/day). *Binge drinking frequency* was defined as drinking at least 6 drinks on the same occasion (evening) (Never, Rarely if "*Once a year*", Occasionally if "*several times a year*"/"*once a month*", Frequently if "*once a week or less*"/"*2 to 3 times a week*"/"*4 to 6 times a week*"). Then students declared whether at least once in life they consumed *psychoactive substances* from cannabis, ecstasy, amphetamines, nitrous oxide, inhalation products and cocaine. To determine *physical activity frequency*, we combined walking times and sports by summing the count number of duration in minutes per day (<25, between

25 to 35, >35). *Body Mass Index (BMI) (*<25 vs >=25 kg/m²). Finally, good nutritional habits was based on adherence to The French National Nutrition and Health Program (PNNS) (27). Each of the seven nutrition recommendation was coded 0 if not followed and 1 if followed. The sum (7 representing the highest adherence to recommendations and 0 the lowest) was computed.

Psychosocial covariates: Coping was measured by the Student Coping Scale (28). Three sub-scores are computed representing social support coping, emotional coping and festive coping (higher score represented higher coping resources). *Aggressiveness* was measured by an adaptation of the Brown-Goodwin assessment for Life History of Aggression, translated into French by Bellivier (29). Higher scores represented higher aggressiveness. *Impulsivity* was measured by an Adolescent Version of the Barratt Impulsiveness Scale-11 (BIS-11-A) translated into French by Coudrey F. and Michel G (30). Higher score represent higher impulsivity. *Personality traits* were measured by the Temperament and Character Inventory translated into French by Pélissolo F (31,32). Six sub-scores were computed: novelty seeking, persistence, harm avoidance, determination, reward dependence and cooperativeness. Higher scores represented higher adherence to the type of personality.

Objective health indicator: participants with at least one medical diagnosis for mental or physical diseases or disability at cohort inclusion.

Study size

We performed a sample size calculation for logistic regression between self-esteem and self-rated health, alpha 0.05 and power 0.90. Based on two French studies among college students, we assumed that the distribution of self-esteem was normal (mean=28.9, standard deviation=5.7) (33,34). The proportion of participants who declare having good or very good health has been estimated in 2 studies in Sweden and Italy among college students to be 13 and 23% respectively (35,36). We assumed the odds ratio (OR) to be 1.1 based on the only two studies reported among high school students in South Korea and adults in Canada (1,17). The minimum sample size required was between 232 and 344 depending on self-rated health proportions (SAS software PROC POWER).

Statistical analysis

First we described the study sample. Then, in order to estimate the association between self-esteem and self-rated health, we computed a logistic regression model. We modeled the probability of declaring good or very good self-rated health during the 1st follow-up. The primary explanatory variable was self-esteem. To allow relevant interpretation, we estimate associations for the increase of one standard deviation (i.e. 5.696). All the potential confounders described above were entered in the model as covariates. In the modeling process, we first estimated univariate models. Log-linearity of the effect of self-esteem (continuous variable) was checked. We tested interactions for gender, age and cities among self-rated health and self-esteem links by univariate models and performed stratified analysis if the interaction was significant ($p<0.05$). Then we selected variables if p-value<0.25 to compute multivariate models. Finally, we performed a stepwise backward selection for a final multivariate model with a threshold of p-value=0.05. At every step, we checked the confusion effect and computed the OR, 95% confidential interval (95%CI) and p-value (p) of the corresponding Wald test.

Finally we conducted sensitivity analyses to test the robustness of the findings: (1) modeling self-rated health (a) in continuous variable (ranging from 1 to 5) and (b) in three categories (with an "average" modality); (2) estimating the self-esteem effect throughout a categorized variable (corresponding to quartiles: <=25,]25-28],]28-33], >33) to bring to light a potential dose-response effect; (3) completing the adjustment (a) with baseline self-rated health; (b) forcing the adjustment with delays between the three measurement periods; (c) with objective health indicator; (4) performing primary modeling among the complete case population.

Our missing data analysis procedures used missing at random (MAR) assumptions. We used the MICE (multivariate imputation by chained equations) method of multiple multivariate imputation in SAS software (PROC MI and MIANALYZE) (37,38). We independently analyzed 10 copies of the data, each with missing values suitably imputed, in the multivariate logistic regression analyses. We averaged estimates of the variables to give a single mean estimate and adjusted standard errors

according to Rubin's rules. We imputed only data from covariates using self-esteem, self-rated health, covariates data and completed imputation process with other data collected in the i-share cohort (alcohol consumption, walking time per day, time of sport practice, stress score, anxiety score, depression score and self-rated quality of sleep).

We performed all analyses using the SAS statistical software (SAS version 9.3; SAS Institute Inc, Cary, NC).

RESULTS

The total sample comprised 1011 participants. Figure 1 shows the flow chart of the study population. Of the 14795 college students enrolled in the i-Share cohort, 3613 completed the mental health sub-study, 1038 were eligible for this study and 1011 were ultimately analyzed. Prospective self-rated health assessment (i.e. during the 1st follow-up, Time 3) occurred between 1 and 3 years after inclusion in the cohort (Median=13.2 months) and between 1 month and 3 years after completion of the mental health sub-study (i.e. self-esteem measure, Time 2) (Median=8.4 months). Main baseline characteristics of the study population are presented in Table 1 and the complete description in Table S1 in supplementary material. The mean age of participants was 20.8 (Standard deviation=2.3) years, 795/1011 (79%) were female, 367/1011 (37%) were freshmen and most students were in Bordeaux (686/1011, 68%). 346/1011 (34%) participants had at least one missing data item among covariates. BMI and living situation were the most frequently missing variables (15% and 12% respectively) and other missing variables accounted for less than 5% of missing data. At inclusion, 18% of the students declared average or poor health (183/1011). At 1st follow-up, 20% of the students declared average or poor health (203/1011). Table S2 in supplementary material compare participants of the i-Share cohort versus the study sample.

Self-esteem among students who declared average or poor health at 1st follow-up was lower than students who declared good or very good health (mean=26.2, 95%CI [25.4-27.0] versus mean=28.1, 95%CI [28.8-29.5], p<0.0001). Table 2 presents the final model with crude and adjusted odds ratio

and Table S3 in supplementary material presents the whole modeling process after imputation of missing data. The unadjusted self-esteem effect (for the increase of one standard deviation) on self-rated health was statistically significant (OR=1.70, 95%CI [1.44-1.99], p<0.0001). Log-linearity of the self-esteem effect was confirmed, allowing a valid estimation. All predefined interactions (gender, cities and age) were not statistically significant (all p-values >0.10). The final multivariate model was adjusted for BMI, financial situation during childhood and 3 personality traits (persistence, harm avoidance and cooperativeness). With this final model, the increase of one standard deviation of self-esteem was associated with a 40% increase in the probability of declaring good or very good health versus average to very poor health (adjusted OR=1.40, 95%CI [1.15-1.72], p=0.001).

BMI>25 kg/m², difficult financial situation during childhood decreased by 2 the probability of declaring good to very good health. Three personality traits were associated with self-rated health: low persistence and harm avoidance and high cooperativeness were associated with declaring good to very good health. The restraint model showed acceptable discrimination power (Area Under Curve=0.7205) and the Hosmer-Lemeshow test proved model suitability to data (p-value=0.8614).

Table 3 presents sensitivity analysis results showing the robustness of findings. Whatever the modeling choices for self-rated health and self-esteem or adjusting strategies, higher self-esteem was persistently associated with better self-rated health. Furthermore, the model with self-esteem in four categories showed a dose-response effect with graduate adjusted OR and a significant global test (p<0.04).

DISCUSSION

Findings of study

In this large longitudinal study among college students, higher self-esteem levels were independently associated with better self-rated health, even after complete adjustment for known confounders. This association was not modified by gender or age. Additional risk factors such as BMI, financial situation during childhood and personality traits (persistence, harm avoidance and cooperativeness) were

associated with self-rated health. This original finding opens up an opportunity for interventional research targeting psychosocial resources, especially self-esteem, in the university setting.

Interpretation

The association between higher levels of self-esteem and better self-rated health found in the current study corroborates previous research. This finding based on a sample of college students, supports and extends previous studies on other population samples by showing the same pattern of association between self-esteem and self-rated health (17,1). Several research works and literature reviews formulate hypotheses on the potential underlying mechanisms which could explain the relationship between self-esteem and health. Good self-esteem may enable individuals to make better choices, including adopting healthy behaviors (19). High self-esteem may increase the ability to put in place appropriate strategies to cope with everyday situations, which in turn increases the capacity to feel well and more generally the capacity of resilience (39). An alternative hypothesis is based on bodily sensations (i.e. information that conveys messages from the organism to the brain). This information is available to the individual consciousness, is included in self-rating of health and may reflect important physiological dysregulations, such as inflammatory processes (40). In this hypothesis, self-esteem appears to be a psychosocial ability that allows individuals to better cope with stress and prevents or diminishes these deleterious inflammatory processes. Throughout the literature, several determinants of self-rated health have been found (12). Consistently, we found in our study that a low BMI, a comfortable financial situation during childhood and three personality traits were associated with good self-rated health. In contrast to the literature, we have not found gender differences for self-rated health after complete adjustment (41–43)

. This discordant result could be due to differences in sampling and adjustment strategies. In particular, fewer males than women participated in the i-Share cohort. Moreover, we found that self-rated health was influenced more by the family's financial difficulties during childhood than during college years.

Strengths and limitations

The strengths of our study include the longitudinal design, the standardized assessment tools and the broad adjustment for confounders. In addition, this study investigates self-rated health among college students, a population that has received less attention in the literature. Although the study sample included only a fraction of the original I-Share cohort, the number of participants was still relatively high compared to the available studies in the area. A set of limitations should however be considered to properly interpret the findings. First, a sampling bias could have arisen since participants were mainly healthy female students thus limiting the generalization to other student populations. Since young females usually have lower self-reported health than males caution should be taken regarding the extrapolation of the results to males(44). Second, we used a longitudinal design with a median follow-up period of 8 months, which is relevant to assess impact on self-rated health in young adults. But we do not have any information on persistency of the self-esteem/self-rated health relationship in the longer term, especially after the academic years. Moreover, reverse causation between self-esteem and self-rated health may exist and could not be investigated with our design. However, in sensitivity analyses, when self-rated health measurement prior to self-esteem was entered in the model as a covariate, the result remained similar. Further research should use repeated self-esteem and self-rated health measurements to better explore the bidirectionality assumption.

Implications

From a public health perspective this study provides a contributive insight for interventional research. It suggests that interventions targeting self-esteem during college years should be experimented. Yet the type of intervention is still to be determined since most of the previous interventional research on self-esteem has concerned children (15,16). Consequently, further studies are needed to investigate whether these interventions could be extended or transferred to college students.. Self-esteem improvement interventions could focus either on (1) global self-esteem by increasing self-knowledge and resilience through an individual intervention, web-based for instance, or (2) a specific dimension such as social self-esteem by using exercise or mentoring program (15,16). Further, the university

years represent a relevant period for implementing early interventions, before health behaviors and mental health problems set in.

From a research perspective, we have identified two priority areas. First, it appears necessary to better understand the pathways between self-esteem and self-rated health conducting mediational analyses. Second, the self-reported nature of the 2 measures (i.e. self-esteem and self-rated health) might explain why they are linked (40). Considering that self-esteem has been reported to be linked with health outcomes other than self-rated health, we believe that associations with both the evaluation framework and health are coexisting.

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CONFLICTS OF INTEREST

None declared

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Tables

Table 1. Characteristics of the study population concerning outcome (i.e. self-rated health), main exposure variable (i.e. self-esteem) and demographic data at Time 1: cohort enrolment, Time 2: optional mental health survey, Time 3: cohort follow-up in the i-Share Cohort, France, 2013-2016. n=1011

Characteristics	Participants n=1011	
Outcome at Time 3		
SRH 5-items, n (%)		
Very good	225	(22.3)
Good	583	(57.7)
Average	177	(17.5)
Poor	26	(2.6)
Very poor	0	(-)
SRH dichotomized, n (%)		
Very good to good	808	(79.9)
Average to very poor	203	(20.1)
SRH in continuous[a], median (IQR)	2.0	(2.0 ; 2.0)
Main exposure at Time 2		
Self-esteem in continuous variable, median (IQR)	28	(25 ; 33)
Self-esteem in categorical variable, n (%)		
≤25	287	(28.4)
]25-28]	219	(21.7)
]28-33]	277	(27.4)
>=33	228	(22.6)
Demographic data		

Age at Time 3, mean (STD)	20.8	(2.3)
Female, n (%)	795	(78.6)
BMI <25 Kg/m² at Time 1, n (%)	909	(89.9)

n: number of participants; IQR: Interquartile Range; STD: Standard deviation BMI: Body Mass Index ; SRH: self-rated health

[a] *1=Very good, 2=Good, 3=Average, 4=Poor, 5=Very poor*

Table 2. Final logistic model of probability to declare good or very good compared to very poor, poor or average self-rated health after imputation of missing data on covariates. The i-Share Cohort, France, 2013-2016. n=1011

	Self-rated health[a], n(%) or median (IQR)		**Multivariate model**	
	Good / very good, n=808	Average / poor, n=203	aOR	95%CI
Self-esteem (for the increase of one standard deviation[b])	29 (26-33)	26 (22-30)	1.40	1.15 ; 1.72***
BMI at inclusion				
<25 kg/m²	623 (89.6)	130 (81.3)	2.11	1.26 ; 3.53***
>=25	72 (10.4)	30 (18.8)	1	-
Financial situation during childhood				
Comfortable to very comfortable	487 (60.3)	86 (42.4)	1.87	1.35 ; 2.59***
Correct to very difficult	321 (39.7)	117 (57.6)	1	-
Personality				
Persistence	29 (24-31)	29 (25-33)	0.94	0.91 ; 0.97***
Harm avoidance	26 (22-30)	29 (25-33)	0.95	0.92 ; 0.98***
Cooperativeness	32 (29-35)	32 (28-35)	1.04	1.01 ; 1.08**

n: number of participants; IQR: Interquartile Range; BMI: Body Mass Index; OR: Odds Ratio; 95%CI: 95% Confidence Interval

[a] Self-rated health description provided before data-imputation

[b] Self-esteem standard deviation: 5.696

*p-value<0.25; **p-value<0.05; ***p-value<0.01

Table 3. Sensitivity analysis of the effect of self-esteem on self-rated health. The i-Share Cohort, France, 2013-2016. n=1011

	Estimation[a] of increase of one standard deviation[b] for (1), (3) and (4) and natural scale for (2) of self-esteem effect on self-rated health
(1) modeling self-rated health	
(a) in continuous variable (ranging from 1 to 5)[c]	β=-0.05 p=0.0005
(b) in three categories (with a "average" modality)	
Average versus Poor/very poor	OR=1.69 p =0.0429
Good/very good versus Poor/very poor	OR=2.23 p =0.0015
(2) estimating self-esteem effect throughout a categorized variable	
]25-28] vs ≤25	OR=1.25 p=0.3032
]28-33] vs ≤25	OR=2.28 p=0.0009
>33 vs ≤25	OR=1.85 p=0.0301
(3) completing adjustment	
(a) with baseline self-rated health	OR=1.29 p=0.0160
(b) forcing the adjustment with delays between the three measurement periods	OR=1.40 p=0.0009
(c) with objective health indicator	OR=1.40 p=0.0011
(4) performing primary modeling among complete case population (n=665)	OR=1.55 p=0.0009

OR: Odds Ratio; p: p-value

[a] *Models adjusted for Body Mass Index, financial situation during childhood, personality scores (persistence, harm avoidance, cooperativeness)*

[b] *Self-esteem standard deviation: 5.696*

[c] *High score represent better self-rated health*

Figures

Figure 1. Flow diagram showing participant flow through the study based on the i-Share Cohort, France, 2013-2016.

Supplementary material

Figure S1. Timeline of data collection in I-Share

Table S1. Characteristics of the study population concerning educational, financial, social, geographical, follow up, behavioral and psychological data at Time 1: cohort enrolment, Time 2: optional mental health survey, Time 3: cohort follow-up in the i-Share Cohort, France, 2013-2016. n=1011

Table S2. Comparison of characteristics between the i-share population and the study sample. The i-Share Cohort, France, 2013-2016.

Table S3. Univariate and multivariate logistic model of probability to declare good or very good compared to very poor, poor or average self-rated health after imputation of missing data on covariates. The i-Share Cohort, France, 2013-2016. n=1011

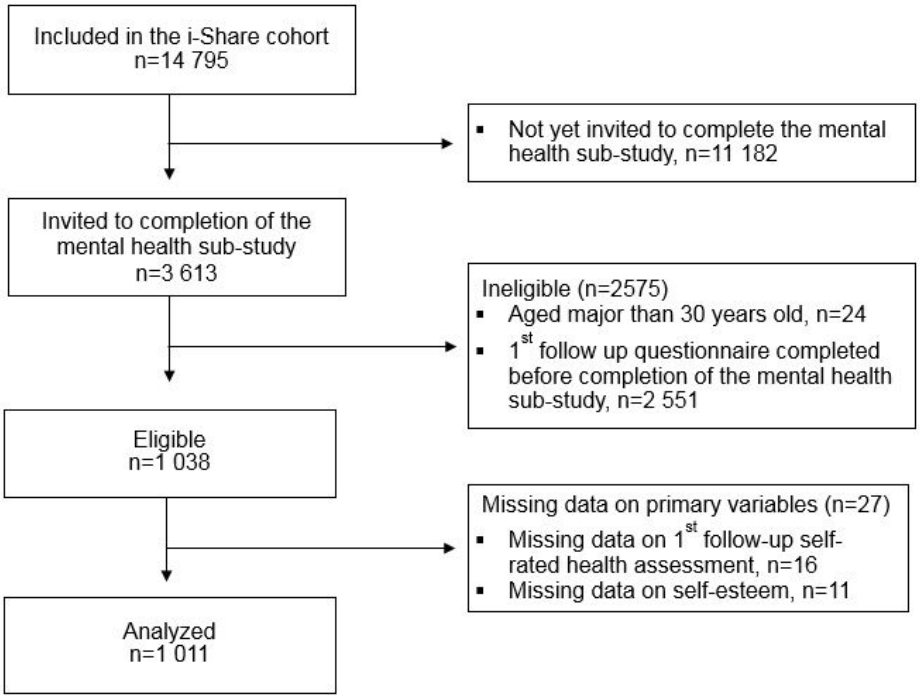

Figure 1. Flow diagram showing participant flow through the study based on the i-Share Cohort, France, 2013-2016.

187x134mm (96 x 96 DPI)

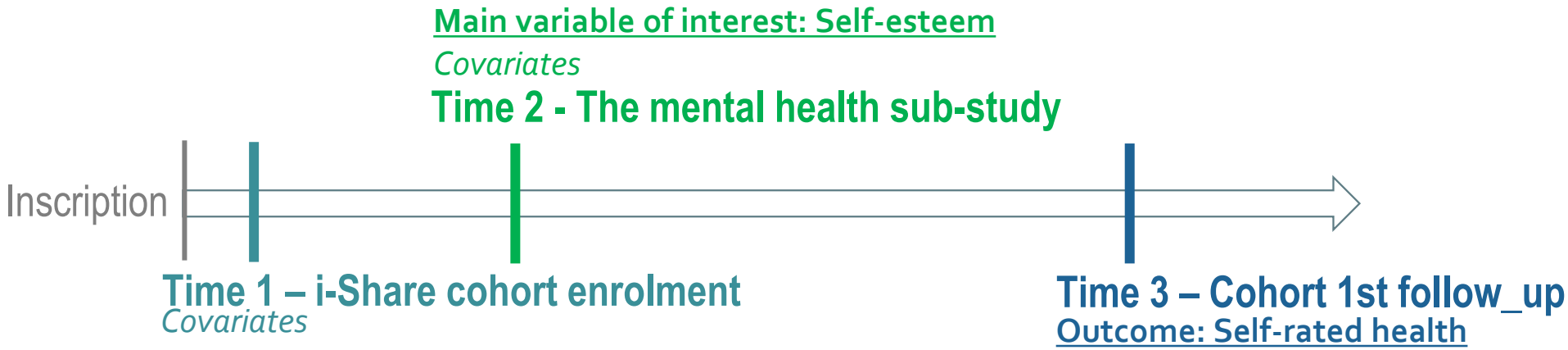
Main variable of interest: Self-esteem
Covariates
Time 2 - The mental health sub-study
Inscription
Time 1 – i-Share cohort enrolment
Covariates
Time 3 – Cohort 1st follow_up
Outcome: Self-rated health

Table S1. Characteristics of the study population concerning educational, financial, social, geographical, follow up, behavioral and psychological data at Time 1: cohort enrolment, Time 2: optional mental health survey, Time 3: cohort follow-up in the i-Share Cohort, France, 2013-2016. n=1011

Characteristics	Participants n=1011	
Educational data at Time 1, n (%)		
University year		
Freshman	367	(36.5)
Sophomore	218	(21.7)
Junior	154	(15.3)
Senior	267	(26.5)
At least one parent with high education level	274	(28.5)
Financial data at Time 1, n (%)		
Comfortable to very comfortable financial situation during childhood	573	(56.7)
Rather satisfied to very satisfied with financial resources	504	(49.8)
Social data at Time 1, n (%)		
Cohabitation		
With parents	278	(31.3)
Flatsharing or couple	287	(32.4)
No cohabitation / alone	322	(36.3)
Strong familial support during childhood	730	(72.9)
Geographical and follow-up data		
City of the registration university at Time 1, n (%)		
Bordeaux	686	(67.9)
Versailles	77	(7.6)
Nice	22	(2.2)
Paris	45	(4.5)
Other	181	(17.9)
Delay in months between inclusion and SRH assessment (follow-up), median (IQR)	13.2	(12.3 ; 23.4)
Delay in months between mental health assessment and SRH assessment (follow-up), median (IQR)	8.4	(3.2 ; 12.0)
Behavioral data at Time 1		
Tobacco consumption, n (%)		
None	761	(75.3)
<=10 cigarettes	213	(21.1)
>10 cigarettes	37	(3.66)
Alcohol consumption frequency during evening, n (%) (MD=40/1)		
Never	22	(2.3)
Rarely	225	(23.2)
Occasionally	393	(40.5)
Frequently	330	(34.0)
Psychoactive substance consumption at least once in life, n (%)	603	(59.6)
BMI <25 Kg/m² at Time 1, n (%)	909	(89.9)
Accordance with nutritional French recommendations, median (IQR)	3	(3 ; 4)
Physical activity, n (%)		
Less than 25 min/day	109	(10.9)
Between 25 and 35 min/day	183	(18.3)
More than 35 min/day	706	(70.7)
Psychological data at Time 2, median (IQR)		
Coping - Social support	11	(8 ; 14)
Coping - Emotional	20	(17 ; 22)
Coping - Festive-addictive	11	(9 ; 14)

Impulsivity	61	(56 ; 67)
Aggressiveness	1	(0 ; 3)
Personality - Novelty seeking	20.5	(18 ; 23)
Personality - Persistence	28	(24 ; 31)
Personality - Harm avoidance	27	(22 ; 31)
Personality - Determination	27	(23 ; 31)
Personality - Reward dependence	28	(23 ; 32)
Personality - Cooperativeness	32	(29 ; 35)

n: number of participants; IQR: Interquartile Range; BMI: Body Mass Index ; SRH: self-rated health

Table S2. Comparison of characteristics between the i-share population and the study sample. The i-Share Cohort, France, 2013-2016.

	i-Share population (< 30 years)and without missing data on self-rated health n=11 925		Study sample n=1 011	
Baseline self-rated health, n (%)				
Very good	2596	(21.77)	(226)	(22.35)
Good	6810	(57.11)	(602)	(59.55)
Medium	2183	(18.31)	(158)	(15.63)
Bad	302	(2.53)	(22)	(2.18)
Very bad	34	(0.29)	(3)	(0.30)
Sex, n (%)				
Male	3036	(25.46)	(216)	(21.36)
Female	8889	(74.54)	(795)	(78.64)
Familial support, n (%)				
DM	212		(9)	
Low	3322	(28.36)	(272)	(27.15)
High	8391	(71.64)	(730)	(72.85)
Financial situation during childhood, n (%)				
Comfortable to very comfortable	6369	(53.41)	(573)	(56.68)
Correct to very difficult	5556	(46.59)	(438)	(43.32)
BMI, median (Q1 ; Q3)	21.39	(19.84 ; 23.44)	21.33	(19.88 ; 23.15)

Table S3. Univariate and multivariate logistic model of probability to declare good or very good compared to very poor, poor or average self-rated health after imputation of missing data on covariates. The i-Share Cohort, France, 2013-2016. n=1011

	Univariate model		Multivariate model	
	OR	95%CI	aOR	95%CI
MAIN EXPOSURE				
Self-esteem (for the increase of one standard deviation[b])	1.70	1.44 ; 1.99***	1.40	1.15 ; 1.72***
COVARIATES				
Demographic data				
Gender				
Male	1	-		
Female	0.48	0.31 ; 0.74***		
Age at self-rated health assessment (follow-up)	0.98	0.92 ; 1.04		
Educational data				
University year at inclusion		*		
1st year / freshman	1	-		
2nd year / sophomore	1.54	1.00 ; 2.37		
3rd year / junior	1.60	0.98 ; 2.62		
4th year or more / senior	1.22	0.83 ; 1.80		
Parents' education level				
At least one with high level	1	-		
Both with low level or only one given with low level	0.86	0.60 ; 1.22		
Financial data				
Financial situation during childhood				
Comfortable to very comfortable	1	-	1	-
Correct to very difficult	0.48	0.36 ; 0.66***	0.54	0.39 ; 0.74***
Satisfaction with financial resources at inclusion				
Rather satisfied to very satisfied	1	-		
Completely dissatisfied to satisfied	0.55	0.40 ; 0.75***		
Social data				
Cohabitation at inclusion				
No cohabitation	1	-		
With parents	1.03	0.70 ; 1.51		
Flat sharing or couple	1.12	0.76 ; 1.64		
Familial support during childhood				
Strong	1	-		
Weak	0.56	0.40 ; 0.78***		
Geographical and follow-up data				
City of the registration university				
Bordeaux	1	-		
Versailles	1.16	0.63 ; 2.14		
Nice	1.16	0.39 ; 3.49		
Paris	1.04	0.49 ; 2.20		
Other	1.08	0.71 ; 1.63		
Delay in months between inclusion and self-rated health assessment (follow-up)	1.00	0.97 ; 1.03		
Delay in months between mental health assessment and self-rated health assessment (follow-up)	1.00	0.98 ; 1.02		
Behavioral data				
Tobacco consumption at inclusion				
None	1	-		
<=10 cigarettes	0.97	0.66 ; 1.42		

>10 cigarettes	0.66	0.31 ; 1.40		
Alcohol consumption frequency during evening at inclusion		**		
Never drink	1	-		
Never binge	1.09	0.41 ; 2.91		
Occasionally binge	1.53	0.58 ; 4.05		
Frequently binge	1.99	0.75 ; 5.33		
Psychoactive substance consumption				
Never	1	-		
Once in life	1.26	0.92 ; 1.72*		
BMI at inclusion				
<25 kg/m²	1	-	1	-
>=25	0.52	0.33 ; 0.81***	0.50	0.31 ; 0.80***
Accordance with nutritional French recommendations	0.97	0.85 ; 1.10		
Physical activity				
More than 35 min/day	1	-		
Less than 25 min/day	0.89	0.54 ; 1.44		
Between 25 and 35 min/day	1.01	0.67 ; 1.52		
Psychological data				
Coping				
Social support	1.03	0.99 ; 1.08*		
Emotional	0.93	0.90 ; 0.97***		
Festive-addictive	1.04	1.00 ; 1.09*		
Impulsivity	0.99	0.97 ; 1.01*		
Agressiveness	0.95	0.90 ; 1.00**		
Personality				
Novelty seeking	1.02	1.00 ; 1.06*		
Persistence	0.95	0.92 ; 0.97***	0.94	0.91 ; 0.97***
Harm avoidance	0.91	0.89 ; 0.94***	0.95	0.92 ; 0.98***
Determination	1.07	1.04 ; 1.10***		
Reward dependence	1.03	1.01 ; 1.06**		
Cooperativeness	1.04	1.01 ; 1.08***	1.04	1.01 ; 1.08**

n: number of participants; IQR: Interquartile Range; BMI: Body Mass Index; OR: Odds Ratio; 95%CI: 95% Confidence Interval

[a] Self-rated health description provided before data-imputation

[b] Self-esteem standard deviation: 5.696

*p-value<0.25; **p-value<0.05; ***p-value<0.01

STROBE 2007 (v4) checklist of items to be included in reports of observational studies in epidemiology*

Checklist for cohort, case-control, and cross-sectional studies (combined)

Section/Topic	Item #	Recommendation	Reported on page #
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1,3
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	3
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	5,6
Objectives	3	State specific objectives, including any pre-specified hypotheses	6
Methods			
Study design	4	Present key elements of study design early in the paper	7
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	6,7
Participants	6	(*a*) *Cohort study*—Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up *Case-control study*—Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls *Cross-sectional study*—Give the eligibility criteria, and the sources and methods of selection of participants	6,7
		(*b*) *Cohort study*—For matched studies, give matching criteria and number of exposed and unexposed *Case-control study*—For matched studies, give matching criteria and the number of controls per case	NA
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	7,8,9,10
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	*7,8,9,10*
Bias	9	Describe any efforts to address potential sources of bias	8,10,11
Study size	10	Explain how the study size was arrived at	10
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	7,8,9,10
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	10,11
		(*b*) Describe any methods used to examine subgroups and interactions	10,11
		(*c*) Explain how missing data were addressed	11
		(*d*) *Cohort study*—If applicable, explain how loss to follow-up was addressed *Case-control study*—If applicable, explain how matching of cases and controls was addressed *Cross-sectional study*—If applicable, describe analytical methods taking account of sampling strategy	14
		(*e*) Describe any sensitivity analyses	11
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	11,12
		(b) Give reasons for non-participation at each stage	Figure 1

		(c) Consider use of a flow diagram	Figure 1
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	12 + Table 1 + Table 1 supp
		(b) Indicate number of participants with missing data for each variable of interest	12
		(c) *Cohort study*—Summarise follow-up time (eg, average and total amount)	12
Outcome data	15*	*Cohort study*—Report numbers of outcome events or summary measures over time	12 + Table 1
		Case-control study—Report numbers in each exposure category, or summary measures of exposure	
		Cross-sectional study—Report numbers of outcome events or summary measures	
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	12 + Table 2
		(*b*) Report category boundaries when continuous variables were categorized	
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	13 + Table 3
Discussion			
Key results	18	Summarise key results with reference to study objectives	13
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	14
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	13,14
Generalisability	21	Discuss the generalisability (external validity) of the study results	15
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	16

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

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Is self-esteem associated with self-rated health among French college students? A longitudinal epidemiological study, the i-Share cohort

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Secondary Subject Heading:	Epidemiology, Mental health
Keywords:	self-esteem, self-rated health, psychological determinants, students, cohort study

Is self-esteem associated with self-rated health among French college students? A longitudinal epidemiological study, the i-Share cohort

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ABBREVIATIONS

95%CI: 95% Confidence Interval

BMI: Body Mass Index

IQR: Interquartile range

MICE: Multivariate Imputation by Chained Equations

OR: Odds Ratio

p: p-value

ABSTRACT

Objectives: The aim of the study was to estimate the association between self-esteem and subsequent self-rated health during college years, taking into account a wide range of potential confounders.

Design: Prospective longitudinal study.

Setting: The French i-Share cohort.

Participants: The sample consisted of 1011 college students.

Primary and secondary outcome measures: The association between self-esteem and later self-rated health was evaluated using multivariate modeling.

Data regarding self-rated health, global self-esteem and demographic, educational, social, behavioral, environmental and financial characteristics were collected through an internet-based questionnaire.

Results: The 1011 participants had a median age of 21.9 years and 79% (795/1011) were females. Self-rated health was assessed a median of 8 months after the self-esteem measurement. Twenty percent of the students declared average to very poor health (203/1011). Students with higher levels of self-esteem were more likely to declare good or very good self-rated health (adjusted odds ratio=1.40, 95% confidence interval [1.15-1.72], p-value=0.001). Other factors associated with good or very good self-rated health were low body mass index, a comfortable financial situation during childhood and three personality traits (low persistence and harm avoidance and high cooperativeness).

Conclusions: This study offers novel findings on the impact of self-esteem on self-rated health among college students. Interventions targeting self-esteem should be experimented during university years in order to improve health outcomes.

Keywords: self-esteem; self-rated health; psychological determinants; students; cohort study

ARTICLE SUMMARY

Strengths and limitations of this study

- The present study is based on a prospective design with a large number of participants
- A broad adjustment was made for confounders to estimate unbiased association
- This study investigates self-rated health among college students, a population that has received less attention in the literature
- Participants were volunteers in the i-Share project which may have caused a sampling bias. Extrapolation to other student populations may be limited.
- Reverse causation between self-esteem and self-rated health may exist and could not be investigated with our design.

AUTHORS' CONTRIBUTIONS

J. Arsandaux and C. Galera developed the study concept and study design. C. Tzourio is the principal investigator of the i-Share Cohort. M. Tournier and G. Michel participated actively in the creation of the mental health questionnaire and brought psychological and psychiatric expertise to the interpretation of the results. J. Arsandaux performed the data analysis and interpretation under the supervision of C. Galera. J. Arsandaux drafted the manuscript and all the co-authors provided critical revisions. All the authors approved the final version of the manuscript for submission.

DATA AVAILABILITY

The scientific committee of the i-share cohort can be contacted for deidentified participant data transferts.

INTRODUCTION

Self-rated health is considered to be a relevant indicator of general health. The high validity, reliability and predictive power of self-rated health make it one of the best predictors of objective health problems (including mortality) and health care utilization (1–6). Collection of self-rated health is recommended by the World Health Organization (WHO) as a standard and cost-effective measure in health surveys (7–10).

Associations between self-rated health and mortality persist even after objective health adjustment, suggesting that self-rated health could constitute an inclusive and universal predictor alongside clinical examination, medical records or self-reports of medical conditions (11).

Determinants of self-rated health problems have attracted interdisciplinary interest. Several studies have investigated demographic, educational, social, behavioral, environmental and financial determinants (12). In addition, a few studies have emphasized the associations between psychosocial resources and self-rated health assessment (13,14). However, there are important limitations in the literature which should be underlined.

First, despite recent research, psychosocial resources have been insufficiently investigated in the literature (14). Among individual characteristics, the impact of self-esteem (i.e. the overall aggregated opinion of oneself at any one time, as defined by Rosenberg) on the rating of one's health remains poorly understood. Yet, it should be noted that self-esteem is a potentially modifiable factor. If self-esteem is predictive of self-rated health independently of other psychosocial confounders, it could represent a specific target for preventive interventions aimed at improving general health. To our knowledge, only two studies have estimated the association between self-esteem and self-rated health, and none among college students (15,1). These studies have reported a significant relationship supporting the hypothesis that high self-esteem is associated with better self-rated health. In addition, a number of studies have evidenced associations between self-esteem and several important health-

related outcomes: academic success, well-being and internalized/externalized mental health problems (16,17).

Second, the population of college students has received little attention in this specific domain. Yet this period corresponding to the transition between adolescence and adulthood is crucial for the development of individuals, as well as for constructing and reinforcing self-esteem. Although the student population is in relatively good health, it is noteworthy that mental health and substance use issues are prevalent during the college years (18–20). On the one hand, self-rated health can serve to evaluate a general health status predicting future health problems before they set in. On the other hand, college is a period of development in which interventions could modify the onset of determinants such as psychosocial resources.

A final limitation is the lack of studies that adjust comprehensively for various risk factors (i.e. the six domains reported above). This implies possible confounding biases that need to be addressed.

The aim of the present study was to estimate the association between self-esteem and subsequent self-rated health during college years, taking into account a wide range of potential confounders in the i-Share cohort.

METHODS

Study population

This study is based on the internet-based Students Health Research Enterprise (i-Share, www.i-share.fr) project, a prospective population-based cohort study of students in higher education institutions in France. The i-Share cohort is one of the largest epidemiological studies conducted on European students and constitutes an opportunity to investigate this research question thanks to its longitudinal collection of multidimensional data on childhood and family history, lifestyle, health information, living conditions and mental and psychosocial examinations(21,22). The objectives of the

i-Share cohort are to evaluate important health aspects among university students over the course of 10 years. The eligibility criteria are to be officially enrolled at a university or higher education institution; to be at least 18 years of age; to be able to read and understand French; and to provide informed consent for participation. Recruitment started in February 2013 and is still ongoing. Students are informed about the objectives of the study through promotion campaigns. In particular, a group of trained students inform their peers about the study and initiate the online recruitment process. The baseline inquiry collected information on students' health, personal and family medical histories, socio-demographic characteristics, and lifestyle habits. Afterwards, students receiv an e-mail invitation to complete follow-up questionnaires annually (on each anniversary of the date of the baseline questionnaire) for 10 years and for sub-study data collection. As of February 6, 2016, 14 795 participants were included in the cohort, with the average age being 21 years and 74% were female. The response rate for one-year follow-up was 18% (n=2607). Since December 2015, an optional mental health survey has been conducted to provide data on several dimensions of mental and psychological health. For this specific study, we used the data available as of April 29th, 2016. We used a longitudinal design to compare self-esteem data collected during the mental health sub-study (Time 2) with the next planned assessment of self-rated health (i.e. during the 1st follow-up of the cohort, Time 3). We used baseline characteristics collected at cohort inclusion for adjustment (Time 1). Figure S1 in the supplementary mùaterial describes the study timeline. Only college students aged between 18 and 30 years old and participating in the mental health sub-study before their 1st follow-up were included. The i-Share project on which this study was based was approved by the Commission Nationale de l'Informatique et des Libertés (CNIL) [DR-2013-019].

'Patient and Public Involvement'

No participants were involved in setting the research questions or measurements, or in developing plans for the design of the study. No participants were asked to advise on the interpretation or writing up of results. However, there are plans to disseminate the results of the research to study participants via the i-share website and social media and by means of a quarterly newsletter sent to participants via

email.A group of trained students also participated during the recruitment process (i.e. informed their peers about the study and initiated the online recruitment process). These students were also involved in the communication campaign, advising the study team about priority messages and communication tools.

Measures and scales

Outcome: Self-rated health

Students gauged their current general self-rated health by the question: "*Do you consider your current health?*" with a five-point response scale ranging from 1 to 5 (1="*Very poor*" / 2="*Poor*" / 3="*Average*" / 4="*Good*" / 5="*Very good*"). The variable was dichotomized as follows: "*Very good / Good*" versus "*Average / Poor / Very poor"*. Psychometric performance of this assessment has been reported in two papers (8,9). Self-rated health was measured at inclusion of the participant and in follow-up questionnaires. The 1st follow-up self-rated health measure corresponded to the primary outcome of this study (Time 3).

Main variable of interest: Self-esteem

Self-esteem was assessed using the Self-Esteem Scale (Rosenberg, 1965), a 10-item self-report measure of global self-esteem. Each item is answered on a 4-point Likert type scale ranging from 1="*Strongly disagree*" to 4="*Strongly agree*". The score can range from 10 (low level of self-esteem) to 40 (high level of self-esteem). The Rosenberg Self-Esteem Scale is the most widely used instrument for the measurement of global self-esteem (23). It was translated into French, and its high reliability and validity were confirmed with a French sample (24). Self-esteem measurement was part of the optional mental health survey (Time 2). We used a continuous score for the primary analysis.

Covariates

All the covariates were collected through the self-administered online questionnaire at cohort enrolment (Time 1), except for the psychosocial covariates which were part of the mental health sub-study (i.e. at the same time as self-esteem measurement, Time 2). They all preceded the outcome to

keep the longitudinal sequence between predictors and outcome. The covariates included in this study covered the 6 domains of potential determinants of self-rated health described in the literature (12):

Demographic covariates: We built the following demographic variables: *sex* (male/female), *age* (in years when the outcome was measured, Time 3).

Academic covariates: Education level of student was collected at cohort inclusion and categorized into: freshman, sophomore, junior and senior. For *parental education level*, we used the education level of the parents declared by the students (at least one of their parents had a higher education level than baccalaureate versus not).

Financial covariates: Self-rated economic situation during childhood ("*Very difficult"/"Difficult"/"Correct"* versus *"Comfortable"/"Very comfortable*") and s*elf-rated satisfaction about financial resources during college* ("*Very satisfied"/"Rather satisfied"* versus *"Satisfied"/"Rather dissatisfied"/"Totally unsatisfied*").

Social covariates: Students' *living conditions* (cohabitation with parents, flatsharing/couple or alone) and *self-rated familial support during childhood* (Weak "*None at all*"/ "*A little*"/"*Moderate*" versus High "*A lot*"/"*Enormous*").

Geographical covariates: Students included in this study were spread over the French territory. To take disparities across college campuses into account we selected the 4 most constitutive *cities of the registration university* in the sample (Bordeaux/Versailles/Nice/Paris/other).

Behavioral covariates: Tobacco consumption (none, ≤10 cigarettes/day, >10 cigarettes/day). *Binge drinking frequency* was defined as drinking at least 6 drinks on the same occasion (evening) (Never, Rarely if "*Once a year*", Occasionally if "*several times a year*"/"*once a month*", Frequently if "*once a week or less*"/"*2 to 3 times a week*"/"*4 to 6 times a week*"). Then students declared whether they consumed *psychoactive substances* at least once in their life, from cannabis, ecstasy, amphetamines, nitrous oxide, inhalation products and cocaine. To determine *physical activity frequency*, we combined walking times and sports by summing the count number of duration in minutes per day (<25, between

25 to 35, >35). *Body Mass Index (BMI) (*<25 vs >=25 kg/m²). Finally, good nutritional habits was based on adherence to The French National Nutrition and Health Program (PNNS) (25). Each of the seven nutrition recommendations was coded 0 if not followed and 1 if followed. The sum (7 representing the highest adherence to recommendations and 0 the lowest) was computed.

Psychosocial covariates: Coping was measured by the Student Coping Scale (26). Three sub-scores were computed representing social support coping, emotional coping and festive coping (a higher score represented higher coping resources). *Aggressiveness* was measured by an adaptation of the Brown-Goodwin assessment for Life History of Aggression, translated into French by Bellivier (27). Higher scores represented higher aggressiveness. *Impulsivity* was measured by an Adolescent Version of the Barratt Impulsiveness Scale-11 (BIS-11-A) translated into French by Coudrey F. and Michel G (28). Higher scores represented higher impulsivity. *Personality traits* were measured by the Temperament and Character Inventory translated into French by Pélissolo F (29,30). Six sub-scores were computed: novelty seeking, persistence, harm avoidance, determination, reward dependence and cooperativeness. Higher scores represented greater adherence to the type of personality.

Objective health indicator: participants with at least one medical diagnosis for mental or physical diseases or disability at cohort inclusion.

Study size

We performed a sample size calculation for logistic regression between self-esteem and self-rated health, alpha 0.05 and power 0.90. Based on two French studies among college students, we assumed that the distribution of self-esteem was normal (mean=28.9, standard deviation=5.7) (31,32). The proportion of participants declaring having good or very good health has been estimated in 2 studies in Sweden and Italy among college students to be 13 and 23% respectively (33,34). We assumed the odds ratio (OR) to be 1.1 based on the only two studies reported among high school students in South Korea and adults in Canada (1,15). The minimum required sample size was between 232 and 344 based on self-rated health proportions (SAS software PROC POWER).

Statistical analysis

First, we described the study sample. Then, in order to estimate the association between self-esteem and self-rated health, we computed a logistic regression model. We modeled the probability of declaring good or very good self-rated health during the 1st follow-up. The primary explanatory variable was self-esteem. To allow relevant interpretation, we estimated associations for the increase of one standard deviation (i.e. 5.696). All the potential confounders described above were entered in the model as covariates. In the modeling process, we first estimated univariate models. Log-linearity of the effect of self-esteem (continuous variable) was checked. We tested interactions for gender, age and cities among self-rated health and self-esteem links by univariate models and performed stratified analysis if the interaction was significant ($p<0.05$). Then we selected variables if p-value<0.25 to compute multivariate models. Finally, we performed a stepwise backward selection for a final multivariate model with a threshold of p-value=0.05. At every step, we checked the confusion effect and computed the OR, 95% confidence interval (95%CI) and p-value (p) of the corresponding Wald test.

Finally we conducted sensitivity analyses to test the robustness of the findings: (1) modeling self-rated health (a) in continuous variable (ranging from 1 to 5) and (b) in three categories (with an "average" modality); (2) estimating the self-esteem effect through a categorized variable (corresponding to quartiles: <=25,]25-28],]28-33], >33) to bring to light a potential dose-response effect; (3) completing the adjustment (a) with baseline self-rated health; (b) forcing the adjustment with delays between the three measurement periods; (c) with objective health indicators; (4) performing primary modeling among the complete case population.

Our missing data analysis procedures used missing at random (MAR) assumptions. We used the MICE (multivariate imputation by chained equations) method of multiple multivariate imputation in SAS software (PROC MI and MIANALYZE) (35,36). We independently analyzed 10 copies of the data, each with suitably imputed missing values, in the multivariate logistic regression analyses. We averaged estimates of the variables to give a single mean estimate and adjusted standard errors

according to Rubin's rules. We imputed only data from covariates using self-esteem, self-rated health, covariate data and completed the imputation process with other data collected in the i-share cohort (alcohol consumption, walking time per day, sport practice time, stress score, anxiety score, depression score and self-rated quality of sleep).

We performed all analyses using the SAS statistical software (SAS version 9.3; SAS Institute Inc, Cary, NC).

RESULTS

The total sample comprised 1011 participants. Figure 1 shows the flow chart of the study population. Of the 14795 college students enrolled in the i-Share cohort, 3613 completed the mental health sub-study, 1038 were eligible for this study and 1011 were ultimately analyzed. Prospective self-rated health assessment (i.e. during the 1st follow-up, Time 3) was a median of 13.2 months after enrolment in the cohort and a median of 8.4 months after completion of the mental health sub-study (i.e. self-esteem measure, Time 2). The baseline characteristics of the study population are presented in Table 1. The mean age of participants was 20.8 (Standard deviation=2.3) years, 795/1011 (79%) were female, 367/1011 (37%) were freshmen and most students were in Bordeaux (686/1011, 68%). 346/1011 (34%) participants had at least one missing data item among covariates. BMI and living situation were the most frequently missing variables (15% and 12% respectively) and other missing variables accounted for less than 5% of missing data. At inclusion, 18% of the students declared average or poor health (183/1011). At 1st follow-up, 20% of the students declared average or poor health (203/1011). Table S1 in the supplementary material compares participants in the i-Share cohort versus the study sample.

Table 2 presents the whole modeling process after imputation of missing data and Table 3 presents the final model with crude and adjusted odds ratios. The unadjusted self-esteem effect (for the increase of one standard deviation) on self-rated health was statistically significant (OR=1.70, 95%CI [1.44-1.99], p<0.0001). Log-linearity of the self-esteem effect was confirmed, allowing a valid estimation. None of

the predefined interactions (gender, cities and age) were statistically significant (all p-values >0.10). The final multivariate model was adjusted for BMI, financial situation during childhood and 3 personality traits (persistence, harm avoidance and cooperativeness). With this final model, the increase of one standard deviation in self-esteem was associated with a 40% increase in the probability of declaring good or very good health versus average to very poor health (adjusted OR=1.40, 95%CI [1.15-1.72], p=0.001).

BMI>25 kg/m² and difficult financial situation during childhood decreased the probability of declaring good to very good health by 2. Three personality traits were associated with self-rated health: low persistence and harm avoidance and high cooperativeness were associated with declaring good to very good health. The restraint model showed acceptable discrimination power (Area Under Curve=0.7205) and the Hosmer-Lemeshow test proved model suitability to data (p-value=0.8614).

Table 4 presents sensitivity analysis results showing the robustness of findings. Whatever the modeling choices for self-rated health and self-esteem or adjusting strategies, higher self-esteem was persistently associated with better self-rated health. Furthermore, the model with self-esteem in four categories showed a dose-response effect with graduate adjusted OR and a significant global test (p<0.04).

DISCUSSION

Findings of the study

In this large longitudinal study among college students, higher self-esteem levels were independently associated with better self-rated health, even after complete adjustment for known confounders. This association was not modified by gender or age. Additional risk factors such as BMI, financial situation during childhood and personality traits (persistence, harm avoidance and cooperativeness) were associated with self-rated health. This original finding opens up an opportunity for interventional research targeting psychosocial resources, especially self-esteem, in the university setting.

Interpretation

The association between higher levels of self-esteem and better self-rated health found in the current study corroborates previous research. This finding based on a sample of college students supports and extends previous studies on other population samples by showing the same pattern of association between self-esteem and self-rated health (15,1). Several research works and literature reviews formulate hypotheses on the potential underlying mechanisms which may explain the relationship between self-esteem and health. Good self-esteem may enable individuals to make better choices, including adopting healthy behaviors (17). High self-esteem may increase the ability to put in place appropriate strategies to cope with everyday situations, which in turn increases the capacity to feel well and more generally the capacity of resilience (37). An alternative hypothesis is based on bodily sensations (i.e. information that conveys messages from the organism to the brain). This information is available to the individual consciousness, is included in self-rating of health and may reflect important physiological dysregulation, such as inflammatory processes (38). In this hypothesis, self-esteem appears to be a psychosocial ability that allows individuals to cope better with stress and prevents or diminishes these deleterious inflammatory processes. Throughout the literature, several determinants of self-rated health have been found (12). Our study was consistent with this in finding that a low BMI, a comfortable financial situation during childhood and three personality traits were associated with good self-rated health. In contrast to the literature, we did not find gender differences for self-rated health after complete adjustment (39–41). This discordant result could be due to differences in sampling and adjustment strategies. In particular, fewer males than women participated in the i-Share cohort. Moreover, we found that self-rated health was influenced more by the family's financial difficulties during childhood than during college years.

Strengths and limitations

The strengths of our study include the longitudinal design, standardized assessment tools and broad adjustment for confounders. In addition, this study investigates self-rated health among college students, a population that has received less attention in the literature. Although the study sample included only a fraction of the original I-Share cohort, the number of participants was still relatively

high compared to the available studies in the area. A set of limitations should be taken into consideration, however, to interpret the findings properly. First, a sampling bias could have arisen since participants were mainly healthy female students. . Since young females usually have lower self-reported health than males caution should be taken regarding extrapolation of the results to males (42). Further research are needed with a larger and more varied sample. Second, we used a longitudinal design with a median follow-up period of 8 months, which is relevant to assess impact on self-rated health in young adults. We do not have any information on the persistency of the self-esteem/self-rated health relationship in the longer term, however, especially after the academic years. Moreover, reverse causation between self-esteem and self-rated health may exist and could not be investigated with our design. However, in sensitivity analyses, when self-rated health measurement prior to self-esteem was entered in the model as a covariate, the result remained similar. Further research should use repeated self-esteem and self-rated health measurements to better explore the bidirectionality assumption.

Implications

From a public health perspective, this study provides a contributive insight for interventional research. It suggests that interventions targeting self-esteem during college years should be experimented. Yet the type of intervention is still to be determined, since most of the previous interventional research on self-esteem has concerned children (43,44). Consequently, further studies are needed to investigate whether these interventions could be extended or transferred to college students. Self-esteem improvement interventions could focus either on (1) global self-esteem by increasing self-knowledge and resilience through an individual intervention, web-based for instance, or (2) a specific dimension such as social self-esteem by using exercise or mentoring program (43,44). Further, the university years represent a relevant period for implementing early interventions, before health behaviors and mental health problems set in.

From a research perspective, we have identified two priority areas. First, it appears necessary to better understand the pathways between self-esteem and self-rated health by conducting mediational

analyses. Second, the self-reported nature of the two measurements (i.e. self-esteem and self-rated health) might explain why they are linked (38). Considering that self-esteem has been reported to be linked with health outcomes other than self-rated health, we believe that there are coexisting associations with both the evaluation framework and health.

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CONFLICTS OF INTEREST

None declared

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Tables

Table 1. Characteristics of the study population concerning self-rated health, self-esteem, demographic, educational, financial, social, geographical, follow up, behavioral and psychological data at Time 1: cohort enrolment, Time 2: optional mental health survey, Time 3: cohort follow-up in the i-Share Cohort, France, 2013-2016. n=1011

Characteristics	Participants n=1011	
Outcome at Time 3		
SRH 5-items, n (%)		
Very good	225	(22.3)
Good	583	(57.7)
Average	177	(17.5)
Poor	26	(2.6)
Very poor	0	(-)
SRH dichotomized, n (%)		
Very good to good	808	(79.9)
Average to very poor	203	(20.1)
SRH in continuous[a], median (IQR)	2.0	(2.0 ; 2.0)
Main exposure at Time 2		
Self-esteem in continuous variable, median (IQR)	28	(25 ; 33)
Self-esteem in categorical variable, n (%)		
≤25	287	(28.4)
]25-28]	219	(21.7)
]28-33]	277	(27.4)
>=33	228	(22.6)
Demographic data		

Age at Time 3, mean (STD)	20.8	(2.3)
Female, n (%)	795	(78.6)
Educational data at Time 1		
University year, n (%)		
Freshman	367	(36.5)
Sophomore	218	(21.7)
Junior	154	(15.3)
Senior	267	(26.5)
At least one parent with high education level, n (%)	274	(28.5)
Financial data at Time 1		
Comfortable to very comfortable financial situation during childhood, n (%)	573	(56.7)
Rather satisfied to very satisfied with financial resources, n (%)	504	(49.8)
Social data at Time 1		
Cohabitation, n (%)		
With parents	278	(31.3)
Flatsharing or couple	287	(32.4)
No cohabitation / alone	322	(36.3)
Strong familial support during childhood, n (%)	730	(72.9)
Geographical and follow-up data		
City of the registration university at Time 1, n (%)		
Bordeaux	686	(67.9)
Versailles	77	(7.6)
Nice	22	(2.2)
Paris	45	(4.5)
Other	181	(17.9)

Delay in months between inclusion and SRH assessment (follow-up), median (IQR)	13.2	(12.3 ; 23.4)
Delay in months between mental health assessment and SRH assessment (follow-up), median (IQR)	8.4	(3.2 ; 12.0)
Behavioral data at Time 1		
Tobacco consumption, n (%)		
None	761	(75.3)
<=10 cigarettes	213	(21.1)
>10 cigarettes	37	(3.66)
Alcohol consumption frequency during evening, n (%)		
Never	22	(2.3)
Rarely	225	(23.2)
Occasionally	393	(40.5)
Frequently	330	(34.0)
Psychoactive substance consumption at least once in life, n (%)	603	(59.6)
BMI <25 Kg/m² at Time 1, n (%)	909	(89.9)
Compliance with French nutritional recommendations, median (IQR)	3	(3 ; 4)
Physical activity, n (%)		
Less than 25 min/day	109	(10.9)
Between 25 and 35 min/day	183	(18.3)
More than 35 min/day	706	(70.7)
Psychological data at Time 2, median (IQR)		
Coping - Social support	11	(8 ; 14)
Coping - Emotional	20	(17 ; 22)
Coping - Festive-addictive	11	(9 ; 14)
Impulsivity	61	(56 ; 67)

Aggressiveness	1	(0 ; 3)
Personality - Novelty seeking	20.5	(18 ; 23)
Personality - Persistence	28	(24 ; 31)
Personality - Harm avoidance	27	(22 ; 31)
Personality - Determination	27	(23 ; 31)
Personality - Reward dependence	28	(23 ; 32)
Personality - Cooperativeness	32	(29 ; 35)

n: number of participants; IQR: Interquartile Range; BMI: Body Mass Index; SRH: self-rated health

[a] *1=Very good, 2=Good, 3=Average, 4=Poor, 5=Very poor*

Table 2. Univariate and multivariate logistic model of probability to declare good or very good compared to very poor, poor or average self-rated health after imputation of missing data on covariates. The i-Share Cohort, France, 2013-2016. n=1011

	Univariate model		Multivariate model	
	OR	95%CI	aOR	95%CI
MAIN EXPOSURE				
Self-esteem (for an increase of one standard deviation[b])	1.70	1.44 ; 1.99***	1.40	1.15 ; 1.72***
COVARIATES				
Demographic data				
Gender				
Male	1	-		
Female	0.48	0.31 ; 0.74***		
Age at self-rated health assessment (follow-up)	0.98	0.92 ; 1.04		
Educational data				
University year at inclusion		*		
1st year / freshman	1	-		
2nd year / sophomore	1.54	1.00 ; 2.37		
3rd year / junior	1.60	0.98 ; 2.62		
4th year or more / senior	1.22	0.83 ; 1.80		
Parents' education level				
At least one with high level	1	-		
Both with low level or only one given with low level	0.86	0.60 ; 1.22		
Financial data				
Financial situation during childhood				

Comfortable to very comfortable	1	-	1	-
Correct to very difficult	0.48	0.36 ; 0.66***	0.54	0.39 ; 0.74***
Satisfaction with financial resources at inclusion				
Rather satisfied to very satisfied	1	-		
Completely dissatisfied to satisfied	0.55	0.40 ; 0.75***		
Social data				
Cohabitation at inclusion				
No cohabitation	1	-		
With parents	1.03	0.70 ; 1.51		
Flat sharing or couple	1.12	0.76 ; 1.64		
Familial support during childhood				
Strong	1	-		
Weak	0.56	0.40 ; 0.78***		
Geographical and follow-up data				
City of the registration university				
Bordeaux	1	-		
Versailles	1.16	0.63 ; 2.14		
Nice	1.16	0.39 ; 3.49		
Paris	1.04	0.49 ; 2.20		
Other	1.08	0.71 ; 1.63		
Delay in months between inclusion and self-rated health assessment (follow-up)	1.00	0.97 ; 1.03		
Delay in months between mental health assessment and self-rated health assessment (follow-up)	1.00	0.98 ; 1.02		
Behavioral data				
Tobacco consumption at inclusion				

None	1	-		
<=10 cigarettes	0.97	0.66 ; 1.42		
>10 cigarettes	0.66	0.31 ; 1.40		
Alcohol consumption frequency during evening at inclusion		**		
Never drink	1	-		
Never binge	1.09	0.41 ; 2.91		
Occasionally binge	1.53	0.58 ; 4.05		
Frequently binge	1.99	0.75 ; 5.33		
Psychoactive substance consumption				
Never	1	-		
Once in life	1.26	0.92 ; 1.72*		
BMI at inclusion				
<25 kg/m²	1	-	1	-
>=25	0.52	0.33 ; 0.81***	0.50	0.31 ; 0.80***
Compliance with French nutritional recommendations	0.97	0.85 ; 1.10		
Physical activity				
More than 35 min/day	1	-		
Less than 25 min/day	0.89	0.54 ; 1.44		
Between 25 and 35 min/day	1.01	0.67 ; 1.52		
Psychological data				
Coping				
Social support	1.03	0.99 ; 1.08*		
Emotional	0.93	0.90 ; 0.97***		
Festive-addictive	1.04	1.00 ; 1.09*		
Impulsivity	0.99	0.97 ; 1.01*		

Agressiveness	0.95	0.90 ; 1.00**		
Personality				
Novelty seeking	1.02	1.00 ; 1.06*		
Persistence	0.95	0.92 ; 0.97***	0.94	0.91 ; 0.97***
Harm avoidance	0.91	0.89 ; 0.94***	0.95	0.92 ; 0.98***
Determination	1.07	1.04 ; 1.10***		
Reward dependence	1.03	1.01 ; 1.06**		
Cooperativeness	1.04	1.01 ; 1.08***	1.04	1.01 ; 1.08**

n: number of participants; IQR: Interquartile Range; BMI: Body Mass Index; OR: Odds Ratio; 95%CI: 95% Confidence Interval

[a] Self-rated health description provided before data-imputation

[b] Self-esteem standard deviation: 5.696

*p-value<0.25; **p-value<0.05; ***p-value<0.01

Table 3. Final logistic model of probability to declare good or very good compared to very poor, poor or average self-rated health after imputation of missing data on covariates. The i-Share Cohort, France, 2013-2016. n=1011

	Self-rated health[a]		Multivariate model	
	Good / very good, n=808	Average / poor, n=203	aOR	95%CI
Self-esteem (for the increase of one standard deviation[b]), median (IQR)	29 (26-33)	26 (22-30)	1.40	1.15 ; 1.72***
BMI at inclusion, n(%)				
<25 kg/m²	623 (89.6)	130 (81.3)	2.11	1.26 ; 3.53***
>=25	72 (10.4)	30 (18.8)	1	-
Financial situation during childhood, n(%)				
Comfortable to very comfortable	487 (60.3)	86 (42.4)	1.87	1.35 ; 2.59***
Correct to very difficult	321 (39.7)	117 (57.6)	1	-
Personality, median (IQR)				
Persistence	29 (24-31)	29 (25-33)	0.94	0.91 ; 0.97***
Harm avoidance	26 (22-30)	29 (25-33)	0.95	0.92 ; 0.98***
Cooperativeness	32 (29-35)	32 (28-35)	1.04	1.01 ; 1.08**

n: number of participants; IQR: Interquartile Range; BMI: Body Mass Index; OR: Odds Ratio; 95%CI: 95% Confidence Interval

[a] Self-rated health description provided before data-imputation

[b] Self-esteem standard deviation: 5.696

*p-value<0.25; **p-value<0.05; ***p-value<0.01

Table 4. Sensitivity analysis of the effect of self-esteem on self-rated health. The i-Share Cohort, France, 2013-2016. n=1011

	Estimation[a] of increase of one standard deviation[b] for (1), (3) and (4) and natural scale for (2) of self-esteem effect on self-rated health
(1) modeling self-rated health	
(a) in continuous variable (ranging from 1 to 5)[c]	β=-0.05 p=0.0005
(b) in three categories (with a "average" modality)	
Average versus Poor/very poor	OR=1.69 p =0.0429
Good/very good versus Poor/very poor	OR=2.23 p =0.0015
(2) estimating self-esteem effect throughout a categorized variable	
]25-28] vs ≤25	OR=1.25 p=0.3032
]28-33] vs ≤25	OR=2.28 p=0.0009
>33 vs ≤25	OR=1.85 p=0.0301
(3) completing adjustment	
(a) with baseline self-rated health	OR=1.29 p=0.0160
(b) forcing the adjustment with delays between the three measurement periods	OR=1.40 p=0.0009
(c) with objective health indicator	OR=1.40 p=0.0011
(4) performing primary modeling among complete case population (n=665)	OR=1.55 p=0.0009

OR: Odds Ratio; p: p-value

[a] *Models adjusted for Body Mass Index, financial situation during childhood, personality scores (persistence, harm avoidance, cooperativeness)*

[b] *Self-esteem standard deviation: 5.696*

[c] *High score represent better self-rated health*

Figures

Figure 1. Flow diagram showing participant flow through the study based on the i-Share Cohort, France, 2013-2016.

Supplementary material

Figure S1. Timeline of data collection in I-Share

Table S1. Comparison of characteristics between the i-share population and the study sample. The i-Share Cohort, France, 2013-2016.

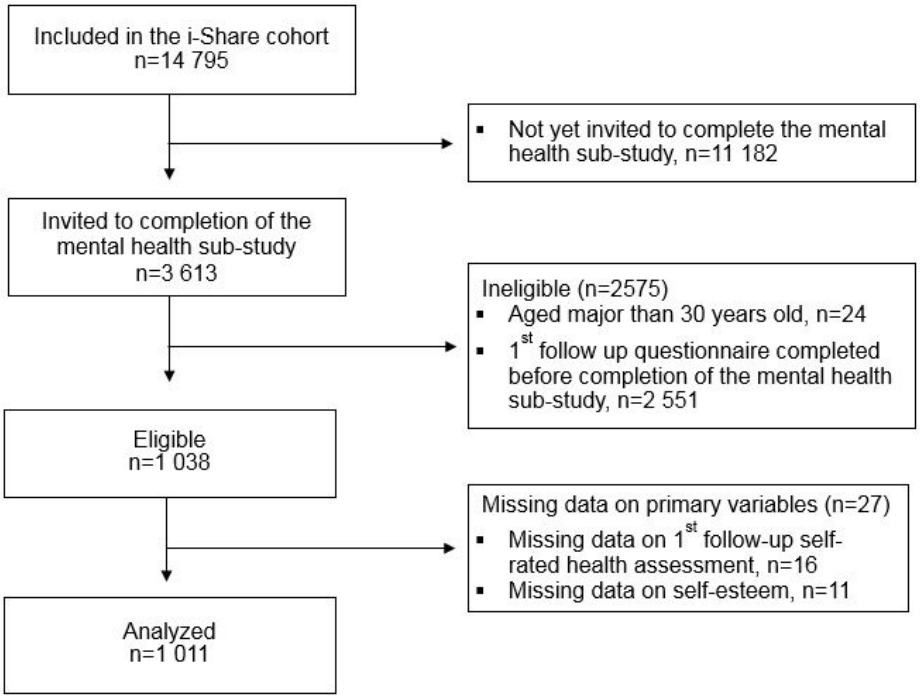

Figure 1. Flow diagram showing participant flow through the study based on the i-Share Cohort, France, 2013-2016.

187x134mm (96 x 96 DPI)

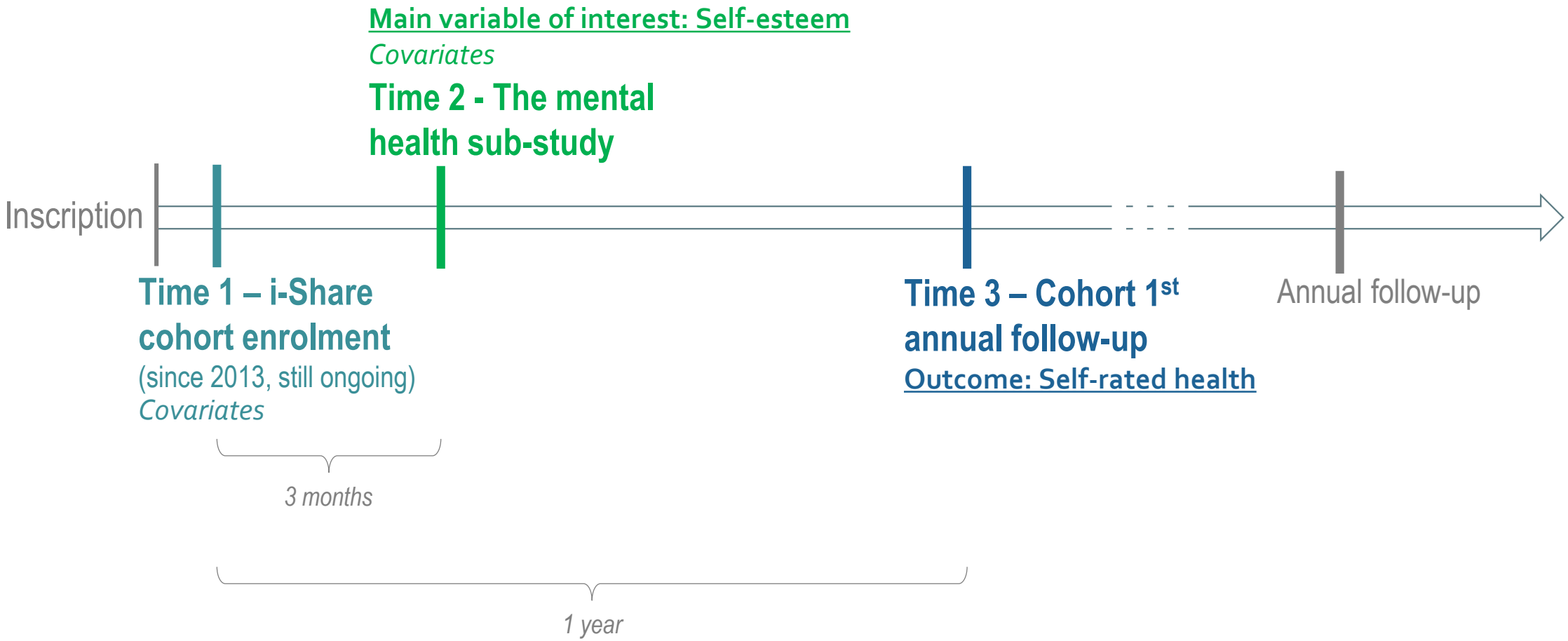
Main variable of interest: Self-esteem
Covariates
Time 2 - The mental health sub-study
Inscription
Time 1 – i-Share cohort enrolment
(since 2013, still ongoing)
Covariates
Time 3 – Cohort 1st annual follow-up
Outcome: Self-rated health
Annual follow-up
3 months
1 year

Table S1. Comparison of characteristics between the i-share population and the study sample. The i-Share Cohort, France, 2013-2016.

	i-Share population (< 30 years)and without missing data on self-rated health n=11 925		Study sample n=1 011	
Baseline self-rated health, n (%)				
Very good	2596	(21.77)	(226)	(22.35)
Good	6810	(57.11)	(602)	(59.55)
Medium	2183	(18.31)	(158)	(15.63)
Bad	302	(2.53)	(22)	(2.18)
Very bad	34	(0.29)	(3)	(0.30)
Sex, n (%)				
Male	3036	(25.46)	(216)	(21.36)
Female	8889	(74.54)	(795)	(78.64)
Familial support, n (%)				
DM	212		(9)	
Low	3322	(28.36)	(272)	(27.15)
High	8391	(71.64)	(730)	(72.85)
Financial situation during childhood, n (%)				
Comfortable to very comfortable	6369	(53.41)	(573)	(56.68)
Correct to very difficult	5556	(46.59)	(438)	(43.32)
BMI, median (Q1 ; Q3)	21.39	(19.84 ; 23.44)	21.33	(19.88 ; 23.15)

STROBE 2007 (v4) checklist of items to be included in reports of observational studies in epidemiology*
Checklist for cohort, case-control, and cross-sectional studies (combined)

Section/Topic	Item #	Recommendation	Reported on page #
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1,3
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	3
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	5,6
Objectives	3	State specific objectives, including any pre-specified hypotheses	6
Methods			
Study design	4	Present key elements of study design early in the paper	7
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	6,7
Participants	6	(*a*) *Cohort study*—Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up *Case-control study*—Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls *Cross-sectional study*—Give the eligibility criteria, and the sources and methods of selection of participants	6,7
		(*b*) *Cohort study*—For matched studies, give matching criteria and number of exposed and unexposed *Case-control study*—For matched studies, give matching criteria and the number of controls per case	NA
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	7,8,9,10
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	*7,8,9,10*
Bias	9	Describe any efforts to address potential sources of bias	8,10,11
Study size	10	Explain how the study size was arrived at	10
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	7,8,9,10
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	10,11
		(*b*) Describe any methods used to examine subgroups and interactions	10,11
		(*c*) Explain how missing data were addressed	11
		(*d*) *Cohort study*—If applicable, explain how loss to follow-up was addressed *Case-control study*—If applicable, explain how matching of cases and controls was addressed *Cross-sectional study*—If applicable, describe analytical methods taking account of sampling strategy	14
		(*e*) Describe any sensitivity analyses	11
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	11,12
		(b) Give reasons for non-participation at each stage	Figure 1

		(c) Consider use of a flow diagram	Figure 1
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	12 + Table 1 + Table 1 supp
		(b) Indicate number of participants with missing data for each variable of interest	12
		(c) *Cohort study*—Summarise follow-up time (eg, average and total amount)	12
Outcome data	15*	*Cohort study*—Report numbers of outcome events or summary measures over time	12 + Table 1
		Case-control study—Report numbers in each exposure category, or summary measures of exposure	
		Cross-sectional study—Report numbers of outcome events or summary measures	
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	12 + Table 2
		(*b*) Report category boundaries when continuous variables were categorized	
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	13 + Table 3
Discussion			
Key results	18	Summarise key results with reference to study objectives	13
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	14
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	13,14
Generalisability	21	Discuss the generalisability (external validity) of the study results	15
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	16

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.