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Introduction of health champions through school nurse-led health education to improve adolescent health literacy in Bangladesh: A quasi-experimental study

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Abstract

Background

Health literacy (HL) is an individual's capacity to obtain, process, and understand health information and services to make appropriate health decisions. It is a crucial social determinant of health and is especially important during adolescence. Evidence on school nurse-led, adolescent-centered HL interventions in low-resource settings remains limited. In Bangladesh, limited school health services, the absence of school nurses, lack of engagement of adolescents for community advocacy and sociocultural barriers contribute to low adolescent HL. Therefore, this study aimed to evaluate the effectiveness of the school nurse-led adolescent health champion model in improving HL among adolescents and its potential impact on community HL.

Methods

A pilot study with a pre–post quasi-experimental design was conducted between February 2024 and August 2025 at a girls' secondary school in a semi-urban area of Bangladesh. School nurses delivered a 3-month health education to 8th-grade students (n = 134). Based on midline performance, 59 students were trained as health champions and facilitated community health education under the supervision of school nurses. After 3 months of health education for the community participants, health champions and community participants were evaluated (endline). Primary outcomes included adolescents' HL measured using the Health Literacy Scale for School-aged Children (HLSAC). Secondary outcomes included self-efficacy, health knowledge, health behaviours and reproductive HL. HL of the community participants (n = 200) were assessed using the European Health Literacy Survey Questionnaire (HLS-Q12).

Results

Adolescents' mean HL score increased significantly from baseline to endline (30.9 ± 3.9 to 37.5 ± 2.1; $p < 0.001$). Significant improvements were also observed in self-efficacy, health knowledge, health behaviours and reproductive HL (all $p < 0.001$). Community participants showed marked improvement in HL with 91.7% and reached an excellent level at the endline. Qualitative analysis indicated increased confidence, leadership, and social responsibility among health champions.

Conclusion

A nurse-led, adolescent health champion model is a feasible and effective approach to improving adolescents' and community people's HL in resource-limited settings. Integrating school nurses-led health education may strengthen adolescent health promotion in Bangladesh.

Background

Health literacy (HL) is a person's social and cognitive ability to get, understand and use health information to make good choices about their health and be able to evaluate health information and services [1, 2]. HL includes skills, like critical thinking, problem-solving and finding ways through complicated health information [3, 4]. HL is seen as a factor that affects people's health. When people have good HL, they can manage their diseases better [5–7], have greater uptake of preventive services (e.g., vaccination and cancer screening), and reduced hospitalization and healthcare costs and reduce morbidity and mortality [8] and have greater access to health-related resources and choices [9].

Adolescence is an important time in one's life when rapid physical, psychological, and social changes occurred and lifelong health behaviours are established [10, 11]. HL during adolescence is crucial for making choices about health and wellbeing and preventing both communicable and non-communicable diseases (CDs and NCDs) [9, 12, 13]. This has direct effects on choices about diet [14], sexual and reproductive health [15], hygiene, and mental health [16, 17]. Investment in adolescent health yields a threefold dividend, including immediate benefits, enduring advantages into adulthood, and enhanced health outcomes for subsequent generations [18].

Despite its relevance, adolescents in low- and middle-income countries (LMICs) commonly report inadequate HL [19, 20]. Physical and sociocultural impediments, such as insufficient incorporation of health education into school curricula, cultural stigma associated with sensitive health issues, dependence on traditional healing methods, and limited access to dependable healthcare services, further hinder adolescents' capacity to cultivate adequate HL [2, 9, 19, 20].

It is recognized that community-based initiatives are effective in improving HL in LMICs. The health champion model is one way to do this. This model is when people help others make choices by empowering and motivating them to take care of themselves [21]. In the United Kingdom, the National Health Service–supported Young Health Champion initiative trains adolescents and young adults aged 14–24 years, equipping them with health knowledge, leadership skills, and confidence to engage as peer educators and advocates within local communities [21].

Globally, it is estimated that over 250 million children and adolescents in 2023 lack basic reading abilities, constituting a key obstacle to HL [22]. Unfortunately, adolescent HL remains uneven and frequently poor, with significant differences between locations and social groups. According to the World Health Organization (WHO), in high-income countries, many children, adolescents, and adults have poor HL skills, and HL varies with social gradient when comparing low versus high socio-economic status which may maintain inequalities [2]. Evidence from school-based surveys in Europe shows high

variation in HL levels among adolescents across nations and population subgroups, such as family socioeconomic status [23, 24]. According to the Organization for Economic Co-operation and Development's "Health at a Glance Report" [25], while childhood and adolescence are crucial times for developing health competence, many 15-year-olds still struggle to evaluate critical thinking skills related to health information. Adolescent HL development is further hampered in many LMICs by inadequate school health systems, restricted access to youth-friendly services, and a lack of a qualified school nursing system. Studies across multiple world regions have found low to moderate levels of HL among young people, influenced by socioeconomic and educational factors [23]. These trends demonstrate the necessity of school-based, equity-focused, and community-based interventions, such as peer-supported and school nurse-led strategies [4, 13, 26].

In Bangladesh, understanding and assessment of HL specially among adolescents, has not been done yet. Only one research study recently conducted validation research translated the Health Literacy for School-Aged Children (HLSAC) instrument into Bengali and verified its usefulness for evaluating health literacy among secondary school adolescents, underscoring the necessity for standardized assessment to guide treatments [27]. The Bangladesh Demographic and Health Survey indicates that teenagers possess inadequate information regarding nutrition, sexual and reproductive health, and preventive health behaviours, especially among females and those from socioeconomically disadvantaged backgrounds [28]. Broader literacy issues additionally impede HL growth; national statistics reveal that 25.5% of the population lacks functional literacy abilities, highlighting basic impediments to receiving and utilizing health information [29]. Additionally, widespread exposure to health misinformation through uncontrolled digital media, such as social media, poses significant hazards to adolescents' health decision-making [26, 30]. The placement of school nurses for health screening is generally unavailable [30]. Together, these considerations underline the critical need for school-based, nurse-led, and adolescent-focused HL interventions in Bangladesh.

Our previous research in Bangladesh indicated that school nurse-led health education in primary schools markedly enhanced children's health awareness, knowledge, behaviours, and specific health outcomes, including decreases in malnutrition and helminthiasis, alongside improvements in Body Mass Index (BMI) [31, 32]. However, these changes didn't have much of an impact outside of school, like in the community. Adolescents, particularly secondary school students, demonstrate increased cognitive maturity, social influence, and leadership capacity, establishing them as potential agents of change capable of disseminating health messages to peers, families, and communities [2]. Despite international evidence supporting adolescents-centered health promotion, such interventions remain limited in Bangladesh.

Study Conceptual Framework

In Bangladesh, population health is affected by a weak healthcare system, insufficient school health services, lack of trained people, limited use of student-centered learning approaches, and gender-based norms that impede women's access to health information and decision-making [13, 33]. These factors contribute to low HL and poor health outcomes. Adolescent girls, however, constitute a significant yet underutilized resource for community health improvement, and evidence demonstrates that empowering girls can positively influence home and community health behaviours [34]. To improve HL among adolescent girls through evidence-based health education, empowerment, and community participation, the conceptual framework (Fig. 1) depicted a community-based pilot program that brought school nurses into a secondary school context. With the help of their families, communities, and schools, students were placed at the core of the framework. A key component of this study was the school nurses, who implemented health education in classrooms and enhanced student empowerment, turning students into advocates as "health champions" who can effect change in their families and communities. To fully maximize nurses' contributions to school health systems, it was imperative to strengthen training opportunities, institutional recognition, and policy integration.

Empowerment through self-awareness and active citizenship came after awareness growth, which included theoretical knowledge, practical skills, and critical thinking [35]. Through health examinations and structured health education, students first gained an awareness of their own health, which they then applied to their everyday lives. Then they were inspired to speak up for others and actively participate in their communities by developing skills and expanding their knowledge outside of the classroom. Therefore, we postulated that secondary school students' HL would be improved by the inclusion of school nurses and organized health education (Fig. 1).

Study Aim

We developed a school- and community-based, nurse-led adolescent health champion model. Secondary school girls were trained to improve their own HL and to disseminate health information to community people with support from school nurses and linkage to nearby primary healthcare facilities. This pilot study aimed to evaluate the effectiveness of this model in improving HL among adolescents and its potential impact on community HL.

Methods

Study design, site and duration

This is a single-arm pilot study with a pre- and post-experimental design. The study was conducted between February 2024 and August 2025. A private school was conveniently selected in a semi-urban area of Dohar, Dhaka City, Bangladesh. This school is exclusively for female students. We selected only female adolescents to assess gender-specific health education priorities, as our health educational materials include reproductive health-related information. A total of 2,500 students were studying in this school in academic grades 1–12. The school was affiliated with the Education Board of Bangladesh.

Study participants, recruitment and eligibility criteria

1. Adolescent participants: Female students in 8th grade were selected. The 8th grade students were purposively selected as the research spanned more than one year. We considered this cohort of students who had completed their first year, were accustomed to the school environment and would not encounter the event of graduation during the research period. The students who were absent during the health checkups and those with physical illnesses were excluded from the study.
2. Community participants: Community people who lived in the school district area of Dohar, Dhaka, aged ≥ 18 years, agreed to receive health education and health checkups, and willing to participate, were included. Individuals who planned to move from the study areas during the study period were excluded.

Sample size

Sample size for adolescents was calculated using G*Power software with an effect size of 0.18 [36], α = 0.05, and power = 0.95, yielding 81 participants. Allowing a 20% attrition rate, the estimated sample size was 100. To eliminate students' sense of unfairness and implement it as a school project, all the 8th grade students were invited to participate. Out of 298 students in 8th grade, 138 attended for screening. One hundred and sixty students were absent from school as we conducted the recruitment process on a school holiday without disrupting school activities. Finally, 138 students were recruited at baseline, and 134 completed the study at endline. The sample size for community participants was intentionally set at 200, based on a realistic estimate of the number of students available for participation.

School nurses training

Three faculty members who were registered nurses in Bangladesh (completed four years of nursing education including community nursing) and twelve undergraduate nursing students from the Grameen Caledonian College of Nursing, Bangladesh, were recruited. All of them received one and a half months of intensive face-to-face training in school health. The training was conducted by the researcher, who was a faculty member of a nursing college and had extensive teaching experience. The training covered delivering health education sessions, developing educational materials such as a health booklet, posters, charts, and images, and performing health check-ups. The faculty members were placed as school nurses, while the nursing students served as assistants

Intervention

Health education was delivered using researcher-developed educational materials, including a health booklet, posters, illustrative images, and short educational videos. The health booklet covered a comprehensive range of health topics which was developed following the international guidelines. To improve HL, we included how to access health information [37], critical values (vital signs, BMI, random blood sugar (RBS)) [38], food, nutrition and a healthy diet [39], first aid and emergency management of burns, choking, cuts, and fainting [40], smoking and alcohol use [41], physical activity [42], personal hygiene and sanitation [43], CDs and NCDs [44], and women's health, including menstruation, menstrual hygiene, contraception, family planning, and sexually transmitted diseases topics [45] in this health booklet. During adolescents' period, knowing about these topics can help them lead a healthy lifestyle following healthy habits, which in turn prevent both CDs and NCDs in their later life. Knowledge of women's health can help them maintain proper menstrual hygiene during menstruation and can prevent early pregnancy and unsafe sexual relationships. Knowledge of access to health information, first aid management and understanding critical values play a vital role in health outcomes and can save one's life. Additionally, inadequate knowledge of food and nutrition, particularly among adolescents, contributes to unhealthy eating habits. The health booklet was provided as **Supplementary file 1**.

Study procedures

The school principal approved the placement of school nurses and allocated a designated room on the school premises for research. After obtaining written informed assent from the student and written informed consent from their parent or legal guardian, school nurses conducted a health check-up (height, weight, blood pressure (BP), RBS, and a routine urine examination) and administered a pre-test using a questionnaire to assess students' baseline (T0) HL, self-efficacy, knowledge, behaviour, and reproductive HL. School nurses prepared a schedule based on students' availability after consulting with class teachers and students.

Prior to initiating the health education sessions, participants were shown a short video depicting the current health situation in Bangladesh, to increase awareness of preventable morbidity and mortality emphasizing the importance of health literacy. They delivered face-to-face evidence-based health education once a week for 45–50 minutes per session (12 sessions) with each session focusing on specific health topics outlined in the booklet over 3 months to increase students' HL (Table 1).

Table 1
Health education program for participatory school students

Months	Week 1	Week 2	Week 3	Week 4
1st Month	Introduction to global and Bangladesh health	Health information access (validity)	Critical values (vital signs, BMI, RBS, etc.)	Emergency Management (burn, choking, knife cut, fainting etc.)
2nd Month	Food (classification, healthy food, unhealthy, food label, salt intake) (NCDs from unhealthy diet)	Smoking and alcohol (NCD-related, substance abuse, secondhand smoking)	Physical activity (benefits, sedentary lifestyle, NCD-related)	Women's health (menstruation, menstrual cycle, hygiene, STD, contraception)
3rd Month	Hygiene (water, food, brushing, bath, toileting, healthy habits)	Environmental sanitation and communicable disease (clean, effects on health)	Women's health and societal contribution	Recapping

BMI: body mass index, NCD: non-communicable disease, RBS: random blood sugar, STD: sexually transmitted disease

For each topic, school nurses and research assistants prepared supporting posters and visual materials to reinforce key messages and facilitate better understanding and retention. Each participant received a copy of the health booklet to encourage self-directed learning at home and to support revision beyond classroom sessions. Interactive teaching strategies were emphasized throughout the intervention. Students were divided into small groups (5 groups, each with 25–30 students) and group-based activities such as role-plays were used to enhance peer learning and communication skills. Topics requiring practical skills were taught through hands-on demonstrations, including proper hand-washing techniques, emergency management of choking and burns, and measurement of BP and RBS. Participants were taught BMI calculation, enabling them to monitor their own health status as well as that of their family members and community.

Additionally, video-based self-learning was introduced to reinforce concepts. Overall, the intervention combined didactic instruction, visual learning, practical demonstrations, and participatory activities to enhance students' HL, self-efficacy, and engagement. All activities were conducted in the students' respective classrooms, and education booklets were provided to students to learn and follow health and hygiene practices at home.

After completing a 3-month health education program, midline data collection (T1) was conducted for the students using the same questionnaires as at baseline. Among the students, school nurses selected 60 students (about 50%, 1 group composed of 6 students and 10 groups) as health champions based on their midline questionnaire scores and their expressed willingness to be health champions. The scores were calculated by combining measures of HL, self-efficacy, knowledge, behaviour and reproductive HL and the descending higher scoring students were selected. However, one individual declined to participate; therefore, 59 health champions remained. About 6 health champions formed one team and worked together (a total of about 10 groups).

For the community participants' recruitment, we approached guardians through school students using the snowball sampling technique. On a designated pre-scheduled day, they gathered at a community location (such as community clinics or schools), where research assistants explained the study procedures. Maintaining confidentiality and obtaining individual written informed consent, participants underwent a basic health check-up (height and weight (to calculate BMI), waist girth, pulse, BP and RBS). As there is no routine health check-up system in Bangladesh; therefore, we performed community participants' health check-ups to understand their health and educate them on how to maintain their own health based on their health check-up reports. Participants who had abnormal health checkup results were referred to the nearest health complex for treatment.

After health check-ups, community participants completed a pre-session questionnaire to assess the HL of them prior to the educational session at baseline. Under the guidance of the school nurses, student health champions provided health education sessions for community participants following the same health booklet which they used during their health education program. They promoted people's participation in the sessions involving community leaders, classmates, and primary healthcare workers from the community clinics. The 4-session, 60-minute per session four times over three months education included: 1) Health information access and identify individual's health problems by understanding critical values (e.g. pulse, BP, BMI, RBS), 2) Unhealthy habits (unhealthy food, salt intake, chewing tobacco, NCDs, sedentary lifestyle), 3) Emergency management and medical instructions adherence (doctor's prescription), and 4) prevention of NCDs and benefits and available facilities of health screening (warning signs and complications of hypertension, diabetics, stroke, vaccination, breast examination, cancer screening). At the end of the education program (3 months), participants completed a post-session using the same questionnaire (Fig. 2).

Outcomes measurement

The primary outcome was HL among students. Secondary outcomes were to compare the level of HL among health champions and non-health champions, self-efficacy, health knowledge, health behaviour and reproductive HL among school students. For community members, a change in HL was an outcome.

Measurements

1. HL among students were measured using the Bengali version of the Health Literacy Scale for School-aged Children (HLSAC) [27], originally developed by Paakkari et al., 2016 [35]. The Bengali version of the scale was found to be valid and reliable (Cronbach's alpha = 0.759) for measuring the HL of adolescents in Bangladesh [27]. The scale comprises a 10-item with five predetermined domains (theoretical knowledge, practical

knowledge, critical thinking, self-awareness and citizenship) [46], rated on a four-point Likert scale (1 = not at all true, 2 = not quite true, 3 = somewhat true, and 4 = absolutely true). The total score was calculated as the sum of 10 items ranging between 10 and 40. Higher scores reflect greater HL.

2. Self-efficacy was assessed with a 10-item General Self-Efficacy Scale (GSE) (4-point Likert scale; 1 = not at all true, 2 = hardly true, 3 = moderately true, and 4 = exactly true). The scale was found to be valid and reliable (Cronbach's alpha = 0.80) [47]. The Bengali version of the self-efficacy scale was found to be reliable (Cronbach's alpha = 0.728) for adolescents in Bangladesh [27]. The total score was calculated as the sum of 10 items ranging between 10 and 40. Higher scores reflect greater self-efficacy.
3. Health knowledge was measured using researcher-developed 30-item questionnaires (**Supplementary file 2**). This questionnaire was developed based on the literature review and the contents of the health education booklet. The face validity of the Bengali version of the questionnaire was checked by 110 students from another secondary school prior to this study and was found valid. The knowledge-related multiple-choice questionnaires assess knowledge about BMI, average life expectancy, normal range of BP, emergency management in choking and burns, smoking, physical exercise, menstrual hygiene, STDs, appropriate age of pregnancy, etc. Each correct answer was scored 1 and an incorrect answer was scored zero (0). The total score was calculated as the sum of 30 questions, ranging from 0 to 30, with a higher score indicating greater knowledge.
4. Health behaviour was measured using researcher-developed 8-item questionnaires (**Supplementary file 3**). The Bengali version of the behaviour questionnaire was pretested and face validity was assessed by the school nurse and assistants. The questionnaire (5-point Likert scale) assessed dietary practices, physical activity, hand hygiene, and waste management. The sum score ranges between 8 and 40, all of which were included in health education, with a higher score indicating better behaviour practices.
5. Reproductive HL was assessed by a 19-item Reproductive HL Scale (4-point Likert scale; 1 = poor, 2 = below, 3 = good, 4 = excellent), which was developed by Kawata et al. (2014) in the Japanese language and the scale was found valid and reliable (Cronbach's alpha = 0.88) [48]. The original scale has four factors, such as "women's choice for adopting health information and practice," "self-care during menstruation," "knowledge of the female body," and "sexual discussion with partner." As our participants were adolescents, we excluded factor 4 with permission of the original developer. This scale was translated into Bengali from the Japanese language following forward-backward translation process. This Bengali version was found to be reliable (Cronbach's alpha = 0.825) in this study. The total sum score of this scale ranged between 19–76. A higher score indicates higher reproductive HL.
6. The socio-demographic data included adolescents' age, religion, parental educational qualifications, main earner's occupation, monthly family income, and a previous history of receiving health education.
7. We also assessed school adolescents' reflections on being a health champion using two open-ended questions for qualitative evaluation (1: how did they feel about being a health champion? and 2: did they face any difficulty in providing health education to community participants, and if so, how did they overcome).
8. For community participants, changes in HL score were measured using a valid and reliable (Cronbach's alpha = 0.762) scale, the European Health Literacy Survey Questionnaire (HLS-Q12), short version, developed by Finbraten (2018) in English [49]. We used a Bengali version of the scale, maintaining backwards and forward translation methods by bilingual professionals. The scale was found to be valid and reliable in this study (Cronbach's alpha = 0.927) for our community participants. The scale has 12-item with a 4-point Likert scale; 1 = very difficult, 2 = difficult, 3 = easy, 4 = very easy. There was a "Don't know" response and it was considered as missing. The total score range was 12 to 48. The score is calculated as the sum of the item's numeric values scaled to a range from 25 to 100. The cut-off values were (1) Excellent: > 83.33, (2) Sufficient: > 66.67 and ≤ 83.33, (3) Problematic: > 50 and ≤ 66.67, (4) Inadequate: ≤ 50. The score was calculated only if at least 80% of the items contained valid responses. Otherwise, the score is set to be missing. Thus, we excluded 80 participants from the analysis to explore the score changes in the HL scale among them [50].

Ethical consideration

This study was conducted in accordance with the "Declaration of Helsinki 2024" [51]. Ethical approval was obtained from the Institutional Review Board (IRB) of North South University, Bangladesh (2023/OR-NSU/tRB/0707). Before enrollment, all participants had written assents and their parents' informed consent was ensured by explaining the study purposes and procedures. The minimum risks for health checkups are explained during physical assessment to both parents and students. Participants' rights to withdraw from this study were also ensured. All participant information was anonymized using a unique identification number and confidentiality was strictly maintained throughout the study.

Quality control

Quality assurance of all study activities was ensured through continuous supervision by the researchers. Trained student nurses collected and entered data into a personal password-protected computer. Data quality was ensured through cross-checking within the research team. Weekly team meetings were held during the intervention phase to identify challenges and implement corrective measures.

Data analysis

A per-protocol set analysis was used to explore the efficacy of this study. We considered dropouts when participants were not provided data at midline. Descriptive statistics, including mean, frequency and percentage were used to present the data. The t-test for age and the chi-square test for other socio-demographic characteristics were used to analyze to compare the two groups. For normally distributed data, the behaviour scale was analyzed using a one-way repeated-measured analysis of variance (ANOVA). The total scores of HL, self-efficacy, awareness and knowledge and reproductive HL scales data were not normally distributed; thus, a Friedman and a Wilcoxon signed-rank test were used to analyze the data. A post-hoc test was used to understand which specific times' means differ significantly from each other. To explore the post-hoc test, the Wilcoxon signed-rank test was done, and a significant level was considered at 0.017 (Bonferroni correction). The chi-square test and the Sign test were used to analyze the categorical (low score

10–25, moderate score 26–35, and high score 36–40) comparison of the total score of the HL scale (HLSAC) between and within the groups at each time point, respectively [35]. Further, the HL scale was categorized into five predetermined theoretical components such as theoretical knowledge, practical knowledge, critical thinking, self-awareness and citizenship [35]. Next, to explore the effectiveness of health education and health championship among students, the community people's HL (HLS-Q12) was assessed using the Sign test and the Wilcoxon signed rank test. The statistical significance was set at $p < 0.05$. The statistical software package SPSS for Windows (version 26.0, Armonk IBM Co.) was used for analysis.

The open-ended qualitative responses were analyzed manually using qualitative content analysis [52] by the authors.

Results

All 134 students' data were analyzed and their socio-demographic characteristics are illustrated in Table 2. Based on the criteria, there were 59 and 75 students allocated into the health champion and non-health champion groups, respectively. Their mean age was 13.5 years, and parental education showed notable differences between groups, and both fathers' and mothers' education were significantly higher in the health champion group ($p < 0.05$). In both groups, 10% of students' families were labour (not regular work)/unemployed, and 42.5% of families earned remittances from abroad. Before exposure to the intervention, 91% of the students had never received any school health education **(**Table 2**).**

Table 2
Compared sociodemographic characteristics between health champion and non-health champion (n = 134)

Variables	n (%)	Health champion (n = 59)	Non-health champion (n = 75)	*P*-value
Age (years)				
mean (SD)	13.5 (0.8)	13.5 (0.8)	13.6 (0.9)	0.113
Religion				0.701
Islam	126 (94.0)	56 (94.9)	70 (93.3)	
Hindu	8 (6.0)	3 (5.1)	5 (6.7)	
Father's educational qualification				0.032
Primary (not completed)	41 (30.6)	12 (20.3)	29 (38.7)	
Primary (completed)	47 (35.1)	20 (33.9)	27 (36.0)	
Secondary level (completed)	35 (26.1)	19 (32.2)	16 (21.3)	
Higher secondary level or above	11 (8.2)	8 (13.6)	3 (4.0)	
Mother's educational qualification				0.035
Primary (not completed)	23 (17.2)	9 (15.3)	14 (18.7)	
Primary (completed)	58 (43.3)	22 (37.3)	36 (48.0)	
Secondary level (completed)	41 (30.6)	18 (30.5)	23 (30.7)	
Higher secondary level or above	12 (9.0)	10 (16.9)	2 (2.7)	
Family's main earning source				0.735
Labour/ unemployed	14 (10.4)	6 (10.2)	8 (10.7)	
Farmer	9 (6.7)	5 (8.5)	4 (5.3)	
Business	37 (27.6)	13 (22.0)	24 (32.0)	
Service holder	17 (12.7)	8 (13.6)	9 (12.0)	
Lives abroad	57 (42.5)	27 (45.8)	30 (40.0)	
Monthly family income				0.187
Do not know	85 (63.4)	33 (24.6)	52 (69.3)	
< 10,000 BDT	7 (5.2)	2 (3.4)	5 (6.7)	
10,000 to 20,000 BDT	6 (4.5)	4 (6.8)	2 (2.7)	
> 20,000 BDT	36 (26.9)	20 (33.9)	16 (21.3)	
Received any health education ever				0.098
Yes	12 (9.0)	8 (13.6)	4 (5.3)	
No	122 (91.0)	51 (86.4)	71 (94.7)	
Note: Chi-square test				

The total mean score (SD) of HL increased significantly ($p < 0.001$) from 30.9 (3.9) at T0 to 37.5 (2.1) at T2. Likewise, the mean scores of all other measures, like self-efficacy, reproductive HL, awareness and knowledge, and health behaviour, were gradually improved at T2, showing a statistically significant difference (all, $p < 0.001$). The significant improvements were also observed in the five theoretical components of HL across all five dimensions (all, $p < 0.001$).

In the post-hoc test, there was significant improvement in the total HL and all other measures, considering time point changes (all, $p < 0.001$). Regarding the theoretical components of HL, significant improvements were observed except for critical knowledge (T0 to T1, $p = 0.095$) and self-awareness (T1 to T2, $p = 0.364$). HL, self-efficacy, reproductive HL, awareness and knowledge, and health behaviour improved significantly from T1 to T2 (all, $p < 0.001$) (Table 3).

Table 3
Compare mean differences of each scale at three time points (baseline, midline and endline)

Variables (n = 134)		Baseline (T0)	Midline (T1)	Endline (T2)	Friedman's test	Post hoc test *P*-value (Z value)		
		Mean (SD)	Mean (SD)	Mean (SD)	*P*-value	BL to ML	BL to EL	ML to EL
Health Literacy		30.9 (3.9)	34.7 (3.6)	37.5 (2.1)	< 0.001	< 0.001 (-8.3)	< 0.001 (-10.0)	< 0.001 (-8.89)
Health literacy sub-categories								
	Theoretical knowledge	6.0 (1.2)	7.1 (0.9)	7.4 (0.7)	< 0.001	< 0.001 (-5.53)	< 0.001 (-8.39)	< 0.001 (-4.93)
	Practical knowledge	6.3 (1.2)	7.3 (0.8)	7.7 (0.6)	< 0.001	< 0.001 (-7.29)	< 0.001 (-9.04)	< 0.001 (-6.01)
	Critical knowledge	6.3 (1.4)	6.9 (1.1)	7.6 (0.7)	< 0.001	0.095 (-1.67)	< 0.001 (-7.7)	< 0.001 (-7.35)
	Self-awareness knowledge	6.5 (1.3)	7.8 (0.4)	7.7 (0.5)	< 0.001	< 0.001 (-7.55)	< 0.001 (-7.75)	0.364 (-0.91)
	Citizenship	6.2 (1.2)	7.0 (0.9)	7.6 (0.6)	< 0.001	< 0.001 (-4.41)	< 0.001 (-8.85)	< 0.001 (-7.56)
Self-efficacy		30.7 (4.6)	35.6 (3.3)	37.3 (2.5)	< 0.001	< 0.001 (-8.93)	< 0.001 (-9.53)	< 0.001 (-6.52)
Awareness & Knowledge		13.9 (2.9)	22.9 (2.7)	24.1 (2.5)	< 0.001	< 0.001 (-10.02)	< 0.001 (-10.06)	< 0.001 (-6.85)
Health Behavior		31.4 (3.7)	34.9 (2.6)	36.1 (2.6)	< 0.001a	< 0.001 (-8.18)	< 0.001 (-9.04)	< 0.001 (-5.26)
Reproductive Health Literacy		51.8 (7.6)	67.6 (5.8)	71.2 (3.8)	< 0.001	< 0.001 (-9.93)	< 0.001 (-10.05)	< 0.001 (-7.18)

Note: a = One-way Repeated Measured ANOVA, BL = Baseline, ML = Midline, EL = Endline

Then, we evaluated how the health champion group, which provided community education, improved their HL components, especially self-awareness and citizenship. The non-health champion group experienced significantly higher gains from T1 to T2 in HL, reproductive HL, and awareness and knowledge than the health champion group, although all endline scores of the health champion group were better than those of the non-health champion group. All the dimensions of the HL scale were improved more in the non-health champion groups than in the health champion groups, while the mean differences between the two groups were not statistically significant, except for the practical (p = 0.041) and critical (p = 0.005) knowledge (Table 4).

Table 4
Changes in the mean score of each scale between health champion and non-health champion at midline to endline (n = 134)

Variables	Groups	Midline (T1) mean (SD)	Endline (T2) mean (SD)	*P*-value[a], within group	Mean difference (EL-ML)	*P*-value[b]
Health Literacy	Health champion (n = 59)	36.1 (2.9)	38.0 (1.8)	< 0.001	1.9	< 0.001
	Non-health champion (n = 75)	33.5 (3.7)	37.1 (2.3)	< 0.001	3.6	
Dimensions of the health literacy scale						
Theoretical knowledge	Health champion	7.1 (0.9)	7.4 (0.7)	0.013	0.3	0.112
	Non-health champion	6.5 (1.1)	7.1 (0.7)	< 0.001	0.6	
Practical knowledge	Health champion	7.3 (0.8)	7.7 (0.6)	0.001	0.4	0.041
	Non-health champion	6.7 (1.0)	7.5 (0.6)	< 0.001	0.7	
Critical knowledge	Health champion	6.9 (1.1)	7.6 (0.7)	< 0.001	0.6	0.005
	Non-health champion	6.3 (1.3)	7.5 (0.7)	< 0.001	1.2	
Self-awareness knowledge	Health champion	7.8 (0.4)	7.7 (0.5)	0.052	-0.2	0.114
	Non-health champion	7.4 (1.1)	7.5 (0.7)	0.803	0.1	
Citizenship	Health champion	7.0 (0.91)	7.6 (0.58)	< 0.001	0.7	0.125
	Non-health champion	6.6 (0.93)	7.5 (0.66)	< 0.001	0.9	
Self-efficacy	Health champion	36.8 (2.5)	38.0 (2.3)	< 0.001	1.22	0.067
	Non-health champion	34.7 (3.5)	36.8 (2.6)	< 0.001	2.03	
Awareness & Knowledge	Health champion	25.7 (1.8)	26.2 (1.5)	0.003	0.54	< 0.001
	Non-health champion	20.7 (0.9)	22.4 (1.8)	< 0.001	1.75	
Health Behavior	Health champion	35.8 (2.4)	37.1 (2.1)	< 0.001	1.32	0.716
	Non-health champion	34.1 (2.6)	35.3 (2.8)	< 0.001	1.16	
Reproductive Health Literacy	Health champion	70.4 (5.1)	72.4 (3.9)	< 0.001	1.97	0.001
	Non-health champion	65.2 (5.3)	70.3 (3.5)	< 0.001	4.87	

[a]Wilcoxon signed-rank test, [b]Independent t-test (between mean differences), ML = Midline, EL = Endline

Next, the categorical comparison of the HL scale revealed a significant improvement in both groups from baseline to endline (Health Champion group high level: 62.7% to 94.9%, p < 0.001; non-Health Champion group high level: 26.7% to 80.0%, p < 0.001). Comparison between the groups, at T1 (p < 0.001) and T2 (p = 0.012) were statistically significant (Fig. 3).

Next, the sociodemographic data for the community people were explored. The mean age was 43.5, 85.4% were female, 19.8% studied below the primary level of education, and 82.3% never received any health education **(Supplementary appendix 1)**. Among them, 41.7% did not achieve the valid response on the HLS-Q12 and 42.7% had limited HL (inadequate and problematic scores on the HLS-Q12) at baseline; however, 91.7% had reached the highest level at endline. Thus, 80 community people were not qualified to be categorized according to their HL level. Nevertheless, the health champion group delivered significant health education to the community people, which was evident in the significant improvement of community people's HL from baseline to endline (mean score 50.33 vs 92.49; p < 0.001) (Table 5).

Table 5
Changes in the health literacy scale (HLS-Q12) among the community people

						n = 192 (%)		n = 112
Times	**Do not know**	**Inadequate**	**Problematic**	**Sufficient**	**Excellent**	**P-value[a]**	**Mean (SD)**	**P-value[b]**
Baseline	80 (41.7)	57 (29.7)	25 (13.0)	14 (7.3)	16 (8.3)	< 0.001	50.3 (17.8)	< 0.001
Endline	-	-	-	16 (8.3)	176 (91.7)		92.5 (6.2)	

[a]Sign test, [b]Wilcoxson signed-ranks test

Regarding the open-ended qualitative responses, out of 59 health champions, 49 agreed to share their experiences regarding receiving health education and their role in delivering health education to the community. Mostly, expressed a strong interest in the educational program. Considering their experiences of receiving health education and becoming a health champion, four key categories were identified: overcome psychological barriers, a sense of joy, a sense of being empowered, and a sense of responsibility. First, participants were overcoming psychological barriers, including initial low self-confidence, shyness, and hesitation, which gradually diminished through engagement in the program. Second, a strong sense of joy emerged, with participants reporting increased motivation, enjoyment, and satisfaction in providing health education. Third, a sense of being empowered was evident, as many participants expressed pride in their role as health champions. Finally, participants demonstrated a heightened sense of responsibility, perceiving their role as an opportunity to bring positive change to the community. Next, the participants identified several community engagement challenges with the strategies used to address those challenges. Mostly (n = 15) reported a smooth experience, indicating that no major obstacles were encountered during health education activities, while 34 participants highlighted encountering various challenges. The community people exhibited shyness, a lack of interest, and difficulties in changing their eating habits. The health champion effectively managed this by conducting key health information in small groups, adopting a friendly communication method using visual aids such as pictures, posters, and real-life examples to convey information. Additionally, misconceptions and superstitions were handled through the use of scientific explanations, patience, and positive, respectful discussions. While the community needed more time to understand health information, the health champion relied on illustrations and real-life examples to enhance comprehension and set personal goals **(Supplemental appendix 2).**

Discussion

This study evaluated a school nurse-led health education program and observed a significant improvement in HL among school adolescents and community people in Bangladesh. The results provided evidence that a structured, school-based health champion intervention can meaningfully enhance adolescents' self-efficacy, health knowledge, health behaviour and reproductive health. Once we could improve the HL of school adolescents and prepare them as health advocates, they could considerably contribute to enhancing HL among community people. Collectively, these findings provide substantial evidence for participatory health education models as an effective approach for strengthening adolescent health competencies, particularly in LMICs where formal health education in the school curriculum remains inadequate.

At baseline, most participants (more than 91%) had no prior exposure to formal health education, underlining a large gap in current school- and community-based health promotion activities. These findings correspond with prior research demonstrating that adolescents in LMICs generally lack access to formal, developmentally appropriate health education, despite global recognition of adolescence as a vital phase for building lifelong health practices [2, 11]. Furthermore, the relatively low mean score of HL among students at baseline indicates the vulnerability of this population and emphasizes the compelling need for targeted, age and culturally appropriate intervention to overcome disparities in early HL development.

The intervention yielded substantial gains in HL from baseline to endline, along with considerable improvements in self-efficacy, reproductive HL, awareness and knowledge, and health behaviour. These results align with evidence from other quasi-experimental school HL interventions indicating that structured health education increases adolescents' overall HL and health behaviours [53, 54] and reinforce the central concept of Nutbeam's conceptual model that HL includes functional, interactive, and critical dimensions required for informed decision-making [55]. Improvements across all five theoretical components of HL also support frameworks that promote multidimensional HL skill development in educational settings [55].

The post-hoc analysis found that both critical knowledge and self-awareness increased considerably from baseline to endline, the improvement between baseline and midline for critical knowledge and between midline and endline for self-awareness was not statistically significant. This pattern matches cognitive and developmental theories, suggesting that higher-order abilities like critical evaluation and self-reflection evolve more slowly and typically require longer or iterative instructional exposure [55, 56]. These results show the need to extend intervention duration or implement tailored pedagogical techniques to cultivate crucial HL competences among adolescents.

Although both health champion and non-health champion showed significant enhancements from midline to endline, the comparatively greater gains observed among non-health champions may be attributed to a ceiling effect among health champions, who had reached higher levels of HL. This finding warrants further investigation. A similar trend has been observed in peer-education studies, where trained peer leaders frequently exhibit first advancements, with their peers subsequently achieving similar progress due to enhanced exposure and dissemination of health knowledge [56, 57]. Importantly, this study underlines the importance of health champions not simply as beneficiaries but as agents of diffusion, boosting HL improvements across peers and community members.

Health champions who were selected based on their health education performance, their parents had a higher level of education compared to non-champions indicates the influence of parents' education on their children. Other studies also explained that health awareness could be disseminated from children's parents [58].

Concurrent improvements in self-efficacy and health behaviours among both groups further indicate that enhanced HL was accompanied by increased confidence and health-promoting actions, in line with theoretical models linking knowledge acquisition to behavioural change [59, 60]. However, the absence of a significant difference between-group difference in health behaviour shows that behavioural change may require longer follow-up, sustained reinforcement, and supportive contexts beyond information acquisition alone [60].

Significant improvements were reported in awareness and knowledge in both groups, with non-health advocates displaying much larger progress. This confirms the presence of knowledge transfer from health champions to non-health champions. Importantly, reproductive health knowledge improvements

among the non-health champion group are supported by a broader evidence base showing that peer-led or health champion approaches greatly enhance adolescents' understanding of sexual and reproductive health topics compared with traditional instruction or control groups [61]. Peer education initiatives, for example, have created considerable knowledge increases in sexual and reproductive health outcomes among high school students, demonstrating that interactive, socially proximal teaching strategies may successfully reach adolescents [61].

The qualitative findings provide vital insights into the processes underlying the reported quantitative outcomes. Health advocates expressed improved confidence, less shyness, and a strong sense of responsibility toward eliminating health misunderstandings, particularly reproductive health. These experiences are congruent with empowerment-based educational models that promote participation, leadership advancement, and social responsibility [62]. The ability of teenagers to discuss culturally sensitive themes such as reproductive health is especially significant, given the social and cultural hurdles that often hinder open communication in this domain in many LMICs. Challenges linked to communications, misconceptions, and time restrictions further underscore the complex social context in which adolescent health education is given, reinforcing the necessity for supportive surroundings and ongoing mentorship.

A key strength of the intervention lies in its community outreach component. Health champion students not only improved their own HL but also effectively disseminated health information within their communities, leading to a pronounced increase in community HL levels. The significant increase from inadequate HL (8.3%) at baseline to over 91.7% achieving the highest HL level at endline underscores the potential of adolescent-led health education to extend beyond schools and influence families and communities. The outcomes of this study may be explained using Rogers' Diffusion of Innovation (how new ideas or practices are embraced and disseminated through communication channels over time within a social system) hypothesis [63]. The school nurse-led, health champion-based intervention functioned as an innovation that was disseminated through interpersonal channels within the school social system. Health champions performed as early adopters and change agents, displaying larger improvements in health literacy, self-efficacy, and health habits. The observed spillover of knowledge to non-champions and community members demonstrates the diffusion (how it spreads) process over time, confirming the theory's emphasis on transparency and social networks in the adoption of health innovations [63–65]. From a nursing and public health viewpoint, such community-level benefits are particularly important in resource-limited situations where healthcare workforce issues impede formal health promotion activities. Moreover, the large benefits observed among community members underscore the wider potential of adolescent-led health education campaigns to influence their relatives and communities.

Bangladesh has a weak primary healthcare system. There is no routine health check-up for any age group of the population. People seek treatment when they become ill. Most of our adolescents and community people have had no experience with health check-ups or interpreting their own health data. Therefore, this study provided them with an opportunity to understand the importance of health screening and the condition of their own health. The unawareness of adolescents' health emphasizes the need to strengthen the primary healthcare system to identify risk factors as a preventive measure.

Moreover, the findings of this study provide the building evidence base supporting school-based health education as an effective and scalable technique for promoting adolescent and community HL. The results are particularly significant for nursing practice and policy, as nurses play a crucial role in health education, community engagement, and capacity building. Integrating organized health champion models within school health and nursing-led community initiatives may offer a sustainable avenue for enhancing health literacy and promoting long-term health equity.

Study strengths

Despite its limitations, this study possesses several notable strengths. It provides clear evidence of the effectiveness of a structured, school-based health education appointing students as a health champion in significantly improving adolescents' HL, self-efficacy, and health behaviours over time. The use of multiple assessment points for six months allowed tracking of gradual progress, indicating the sustainability of this program. The inclusion of both health champion and non-health champion groups enabled meaningful comparisons, highlighting the added value of approaches in promoting continuous improvements in HL. The relatively large sample size might increase the generalizability of the findings to the broader population across the country. Overall, the study offers valuable insights that can inform the design of future adolescent health promotion programs.

Study limitations

This study has several limitations. We selected a school from a suburban area, which limits the evaluation of HL among adolescents from urban and rural areas in Bangladesh. Although the health education intervention effectively improved HL among adolescents, the sample was limited to grade 8 students, excluding those from other grades. As a girls' school, we could not include boys; therefore, their HL was not evaluated. The absence of a randomized design may limit causal inference, and self-reported measures are subject to social desirability bias. Future studies with larger, more diverse samples encompassing students from multiple grade levels are recommended to enhance consistency and reduce potential biases.

Conclusions

The health education intervention demonstrated substantial improvements in HL, self-efficacy, health knowledge, health behaviours and reproductive HL among adolescents and HL for the community people. The progressive and marked enhancement of HL underscores the need for a continuous health education program that empowers adolescents to make informed health choices, adopt positive behaviours and prevent diseases. The health champions exhibited greater gains compared to their counterparts, shifting the majority of participants from moderate to high literacy categories. Building strong HL skills enables adolescents to access, understand and apply health information effectively, fostering long-term well-being. It also enhances their ability to engage in health-related discussions, apply knowledge across various settings, and contribute actively to community health efforts. Adolescents' involvement in disseminating knowledge within families and communities could contribute to better health for all.

Abbreviations

HL Health literacy

CDs Communicable diseases

NCDs Non-communicable diseases

HLSAC Health Literacy Scale for School-aged Children

HLS-Q Health Literacy Survey - Questionnaire

Declarations

Ethics approval and consent to participate

This study was approved by the Institutional Review Board/Ethics Review Committee (IRB/ERC) of North South University, Bangladesh (reference number: 2023/OR-NSU/IRB/0707). This study is being conducted according to the Declaration of Helsinki.

Written informed assents were obtained from all participants, and written informed consents were obtained from all parents or legal guardians to participate in this study. Confidentiality of individual information was maintained at all steps of the research.

Consent for publication

Not applicable.

Availability of data and materials

The datasets generated and/or analyzed during the study are available from the corresponding author upon reasonable request. The data are not publicly available due to privacy restrictions.

Competing interests

The authors declare no competing interests.

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Authors' contributions

Popi Rani Bhowmik: Conceptualization, Methodology, Data curation, Investigation, Writing – original draft, Supervision, Project administration. K. A. T. M. Ehsanul Huq: Data curation, Investigation, Writing – original draft, Writing – review & editing. Sadia A Aivey: Formal analysis, Writing – original draft, Writing – review & editing. Abdulfatai Olamilekan Babaita: Formal analysis, Writing – review & editing. Nahida Akhter: Data curation, Investigation. Mohammad Delwer Hossain Hawlader: Methodology, Investigation, Supervision, Project administration. Michiko Moriyama: Conceptualization, Methodology, Data curation, Investigation, Writing – review & editing, Supervision, Funding acquisition, Project administration. All authors provided input to improve the manuscript, read and approved the final version for submission.

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Figures

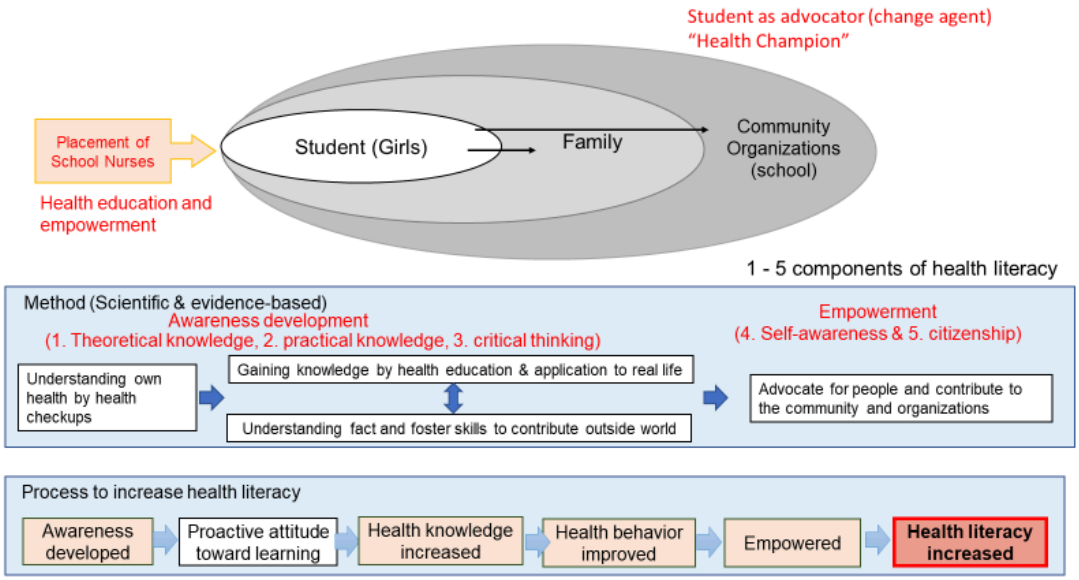

Figure 1

Conceptual framework of this research

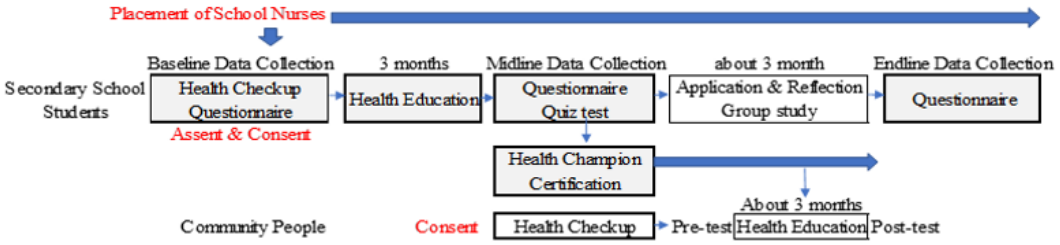

Figure 2

Outline of the study activities

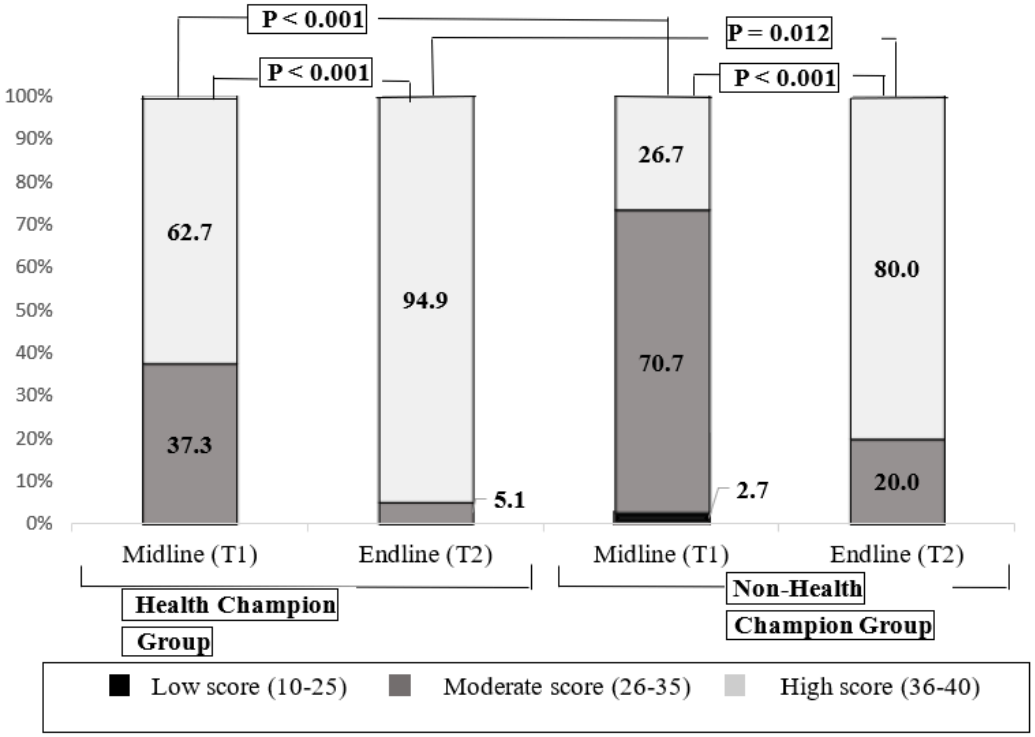

Figure 3

The categorical comparison of health literacy scale at each time point among the students (n = 134)

Supplementary Files

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- Supplementaryappendix.docx