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Teaching Australian high school students to think critically about health claims: a cluster randomized trial

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Abstract

Making informed health decisions requires knowledge and skills in appraising health claims, and teaching adolescents these skills may prepare them for future decision-making. This cluster randomized trial evaluated the effectiveness of an educational intervention on students' ability to identify and appraise health claims. Nine Australian high schools (4 control and 5 intervention) were recruited, comprising 974 students (382 control and 592 intervention) in Grades 7–10. Intervention impact was evaluated through baseline and follow-up evaluation. Follow-up mean scores on questions (maximum score of 25) from the Claim Evaluation Tools database (primary outcome) showed minimal between-group difference (intervention versus control: 14.4 versus 13.6; difference 0.8, 95% confidence interval [CI] −1.6 to 3.1; $P = 0.52$). Change scores were only slightly higher in the intervention group (difference 1.2 [95% CI −0.7 to 3.1; $P = 0.21$]). Between-group differences for secondary outcomes were also minimal. Most intervention group students 'trusted' and 'liked' the programme and found the content 'easy' and 'helpful'. Most teacher feedback was positive, some noting challenges of covering content in allocated time and maintaining student engagement. It is unlikely that the assessed educational intervention had a large effect. Future research priorities are suggested.

Introduction

People are regularly exposed to health information which is highly variable in quality [1–3], leaving them vulnerable to making health decisions based on information that may be misleading, inaccurate, and/or incomplete [4–6]. Misinformed health decisions can waste health-care resources and lead to harm either directly through use of inappropriate interventions or indirectly through delays in seeking appropriate health care [7, 8].

People have become more engaged and autonomous in managing their own health, enabled by the vast amount of easily accessible health information, often through the media and internet [1, 9]. To answer their health queries, people must navigate large amounts of health information, even though many lack the ability to determine the quality of the information they may be using to make decisions and may not be aware of the need to do so [10–12].

A systematic review of studies that evaluated interventions aimed at improving understanding of the key concepts needed to appraise health claims found that such interventions can improve knowledge and skills [13]. Yet, education in these types of skills is not commonly provided to the general public [14] and rarely to adolescents [15, 16]. Adolescence may be an ideal time to provide education in these skills as health-related decisions are starting to be made [17, 18], and the extent of decision-making will increase further with age. Teaching this content during adolescents' formative years

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may mean that awareness of the issue and relevant skills becomes part of their adult capabilities and support future decision-making. Although the broad concept of critical thinking is mentioned in the curriculum for high schools in Australia [19], it is inconsistently addressed and students are not typically taught the knowledge or skills needed to appraise health claims.

A systematic review [15] of the effects of school-based educational interventions for enhancing adolescents' abilities in critically appraising health claims identified eight studies, only one of which involved randomization. The review concluded that educational interventions in schools may have beneficial short-term effects on knowledge and skills relevant to the critical appraisal of health claims [15]. Since that review, a large cluster randomized trial of an educational intervention with Grade 5 students in Uganda has been published, finding an improvement in the ability of students in the intervention group to assess claims about the effects of treatments [20]. The aim of the current study was to evaluate, in a randomized trial, the effect of an educational intervention developed to provide Australian high school students with the knowledge and skills to identify and evaluate health claims.

Materials and methods

This study was approved by the Bond University Human Research Ethics Committee (#LC01939) and registered prospectively at the Australian New Zealand Clinical Trials Registry on 25 February 2020 (12620000231943).

Design

This was a cluster randomized trial, with 1:1 allocation of schools to the intervention and control groups.

Participants

Both independent (private) and public (government) high schools in Australia were eligible, although our ability to invite schools to participate was dependent on state education departments or governing school bodies (for some private schools) granting permission. Schools that provided education only for students with disabilities or special needs or for international students (from non-English-speaking backgrounds) were not eligible. The eligible population within the schools were classes with students between Grades 7 and 10.

Recruitment

High schools in Victoria (VIC), Queensland (QLD), South Australia (SA) and Western Australia (WA) were approached by the research team, initially via email and/or phone, following permission from the appropriate governing organizations where necessary. Schools were not followed up if no response was received after an initial and subsequent follow-up contact. An additional recruitment strategy involved posting notices about the study with relevant groups and organizations, such as state-based science teacher associations. See Supplement B for details about the impact of an intercurrent event (coronavirus disease 2019 (COVID-19) pandemic) on trial recruitment and conduct.

Randomization

After gatekeeper approval was received from the school representative, an independent statistician provided the research team with the school's group allocation. Block randomization (block size 4) was used, and random numbers were generated using SAS software. Allocation concealment occurred at cluster level.

Procedure

Once written student consent was obtained, teachers provided all students with a link to the online baseline questionnaire (Supplement C1: Questionnaire). The ethics committee determined that parental consent was not required, as consent was provided by the principal/school representative and students provided consent for this low-risk educational intervention provided by classroom teachers. Each student was required to create a 5-character identification code at the start of the questionnaire (to maintain anonymity, but enable matching with

their follow-up questionnaire), based on characters such as the first letter from their name and the first letter of the name of the street they live in. The participating teacher(s) then either continued with standard teaching (control group) or delivered the educational programme during class time (intervention group).

All students completed the online follow-up questionnaire, either after teaching was finished (intervention group) or after a similar period of time that delivery of the intervention would require (control group). This period of time was at the control school's discretion—some schools opted to separate the two questionnaires by 4 weeks and others by 1 week. Students were instructed to re-create their unique identification code for the follow-up questionnaire.

Intervention

The educational intervention, titled Health How to Assess Claims Critically (HACC), consists of a teacher guide, student booklet, fictitious health advertisements and PowerPoint presentations (to aid teachers with delivery of the intervention). There are four modules, with the content primarily informed by three research studies: the 'key concepts' considered necessary to be able to critically assess health claims (developed through an international consensus project) [21]; a qualitative study to explore Australian adolescents' understanding of health claims and decisions [16] and gaps in, and findings from, existing studies which were identified in a systematic review [13]. After development, the intervention was refined following feedback from an advisory group (consisting of high school teachers, an educational consultant and students) and from piloting it by teaching (by one of the authors; T.H.) most of the content to two classes of students.

Supplement D contains details of the intervention using the Template for Intervention Description and Replication (TIDieR) [22] items as a guide, a website link containing the programme materials and details about the key concepts that were covered. The estimated duration of each module was 50 min (the length of a standard class period), giving a total intervention duration of approximately four classes (200 min), although the speed of delivery and spacing between modules was at each teacher's discretion.

Intervention materials were mailed to participating schools following randomization. The decision about which teacher taught, or which class received, the programme was made at each school's discretion, and scheduling of the educational intervention was at the teacher's discretion. Due to anticipated pragmatic difficulties in requiring teachers to attend training prior to teaching the content, the teacher guide provided all the information required to deliver the programme. Table I within Supplement D presents the TIDieR checklist which describes details about the intervention providers. Teachers were encouraged to complete all modules and activities; however, if pragmatic issues arose, such as time constraints, they could decide which topics to focus on. Support was offered by the researchers, and the teachers could email or call the research team throughout the trial.

Control

The control teacher(s) continued with standard teaching. Once follow-up data collection was complete, control group schools were offered a copy of the intervention materials, so they could teach the programme to students if desired.

Outcome measures

Primary outcome measure

The primary outcome measure was similar to that used in the Informed Health Choices (IHC) randomized controlled trial [23] and utilized questions from the Claim Evaluation Tools database [24]. IHC is an international organization that develops and evaluates learning resources to enable people to think critically about health claims and make informed choices [25]. They have developed an item bank of multiple-choice questions (the Claim Evaluation Tools database) [24] that assess people's understanding of, and ability to apply, the key concepts [26] that are needed to assess treatment

claims. Items within the database have been developed through extensive qualitative and quantitative feedback from methodological experts, health professionals, teachers and members of the public [21, 23]. They have been rigorously evaluated in several contexts, including Rasch analysis [27], with further psychometric assessments ongoing in several countries, including Australia. For this trial, 19 questions, totalling 25 points (17 questions worth 1 point each and 2 questions worth 4 points each), were selected from the Claim Evaluation Tools database (Supplements C2 and C3), based on their relevance to the topics covered in the Health HACC programme. The same questions were administered baseline and follow-up. The primary outcome analysis was the between-group mean difference in the follow-up score.

Secondary outcome measures

Claim passing and mastery score. A secondary measure was the between-group difference in the proportion of students with a 'passing' score and with a 'mastery' score (defined as a score of $\geq$13 and $\geq$20, out of 25, respectively).

Behaviour and attitude. Six Likert-scale questions asked about intended behaviours, self-efficacy and attitudes towards assessing health claims and were based on those used in the IHC randomized controlled trial [23] (Supplement C1: Qs 20 and 21).

Health advertisement appraisal skills. Students were provided with a fictitious health advertisement that contained a health claim and asked to complete five short answer questions about it (Supplement C1: Q22).

Satisfaction with the intervention (intervention group students only). Eight Likert-scale questions about satisfaction with the intervention were contained in the follow-up questionnaire and only completed by intervention group students (Supplement C1: Qs 23 and 24).

Satisfaction and feasibility (intervention group teachers). After student data collection had finished, teachers at the intervention group schools were provided with a questionnaire that contained 11 open-ended questions about their satisfaction with, and feedback about, the intervention (Supplement E). The intention was to interview teachers to collect these data; however, this was not possible due to the pandemic.

Sample size calculation

An a priori sample size calculation was conducted. A minimum difference between intervention and control groups that was considered important to detect was 3 points (SD 5 points). This was based on the IHC randomized controlled trial [23], which also used questions from the Claim Evaluation Tools database. With 80% power, a significance level of 0.05 (5%) and an assumed intraclass correlation coefficient (ICC) for the effect of clustering of 0.10, based on previous studies [20], it was calculated that 12 schools in total were required, assuming 50 students per school, for a minimum total requirement of 600 students. To allow for up to 15% attrition of students, we increased the sample size to 720 in total (60 students per school).

Data analysis

All analyses were conducted as modified intention-to-treat (mITT), as students who were judged not to have attempted the questionnaire were excluded from the analysis. Inspection of the data revealed that in some cases, students stopped providing answers to the questions at some point in the questionnaire, and some students provided no response to any questions. Results from students who did not attempt to answer at least 13 of the total 25 multiple-choice questions from the Claim Evaluation Tools database were removed from the analysis on the presumption that the students were not genuinely attempting to complete the questionnaire. Missing responses to individual questions were coded as incorrect. Between-group analysis of the scores and change scores was conducted using a mixed effects linear regression model. The effect of clustering was addressed by specifying a random effect for the participating schools.

For the dichotomous outcome measures, mixed logistic regression was used for between-group comparisons. The effect of clustering was addressed by specifying a random effect for the participating schools. An analysis of the change scores was conducted on the data where participants' baseline and follow-up scores could be matched. The secondary outcomes were compared descriptively where possible and feedback was summarized narratively.

Modifications from the protocol

Supplement A presents the trial protocol. Initially, students in Grades 7, 8 and/or 9 were eligible. During recruitment, this was extended to include Grade 10 students to aid recruitment. As many of the baseline scores were unable to be matched to the follow-up scores (primarily due to students not following instructions about how to create a unique code), change scores were unable to be calculated for these participants. Therefore, the main analysis conducted was a between-group comparison of follow-up scores, however an analysis of the change scores was conducted on the data where participants' baseline and follow-up scores could be matched (41% of total participants and 60% of analysed participants). As discussed earlier, mITT is also a modification from the protocol, which stated we planned to use intention-to-treat analysis.

Results

Between August 2020 and November 2021, 100 Australian high schools from across four states (QLD, VIC, WA and SA) were invited to participate, with nine providing consent. All were independent schools, with 7 from QLD and 2 from WA, giving a total of 974 students. Four schools were randomized to the control group ($n = 382$ students) and 5 to the intervention group ($n = 592$ students). Figure 1 shows the trial flow diagram [28].

Table I presents student characteristics. The majority (64%) of students was in Grade 9 and most (83%) participated in the trial within science class. The control group contained a higher proportion of the two lower grades (47% in Grades 7–8) compared with the intervention group (23%). At baseline, the intervention group students scored lower on the primary outcome measure, including the mean total score and the percentage who achieved passing or mastery scores (Table II).

None of the teachers took up the offer for support from the researchers, and comments in the survey from teachers indicated that they felt adequately prepared with the teacher guide alone.

Primary outcome

Table II shows the baseline and follow-up scores from the questions from the Claim Evaluation Tools database and the between-group follow-up difference analysis. The mean follow-up score of the intervention group (14.4) was only slightly higher than the control group mean score (13.6), with a difference of 0.8 (95% confidence interval [CI] −1.6 to 3.1; $P = 0.52$). When change scores were analysed for the participants whose baseline and follow-up scores could be matched, the intervention group achieved a slightly higher change score (1.3 versus 0.08, difference of 1.2 [95% CI −0.7 to 3.1; $P = 0.21$]).

Secondary outcomes

Table II shows that the intervention group had a higher proportion of students who achieved a follow-up passing score (62% versus 54%, odds ratio 1.4 [95% CI 0.65 to 3; $P = 0.38$]), and a higher proportion with a mastery score (16% versus 13%, odds ratio 1.3 [95% CI 0.34 to 5.0; $P = 0.69$]). In both groups, the majority of students achieved a passing score at baseline (59% and 54%, control and intervention groups, respectively) and follow-up (54% and 62%, respectively). The percentage of control group students who achieved a mastery score showed little change (11–13%) between baseline and follow-up, whereas the proportion of intervention students achieving a mastery score increased (5–16%).

Table III shows the outcomes of intended behaviours, self-efficacy and attitudes towards

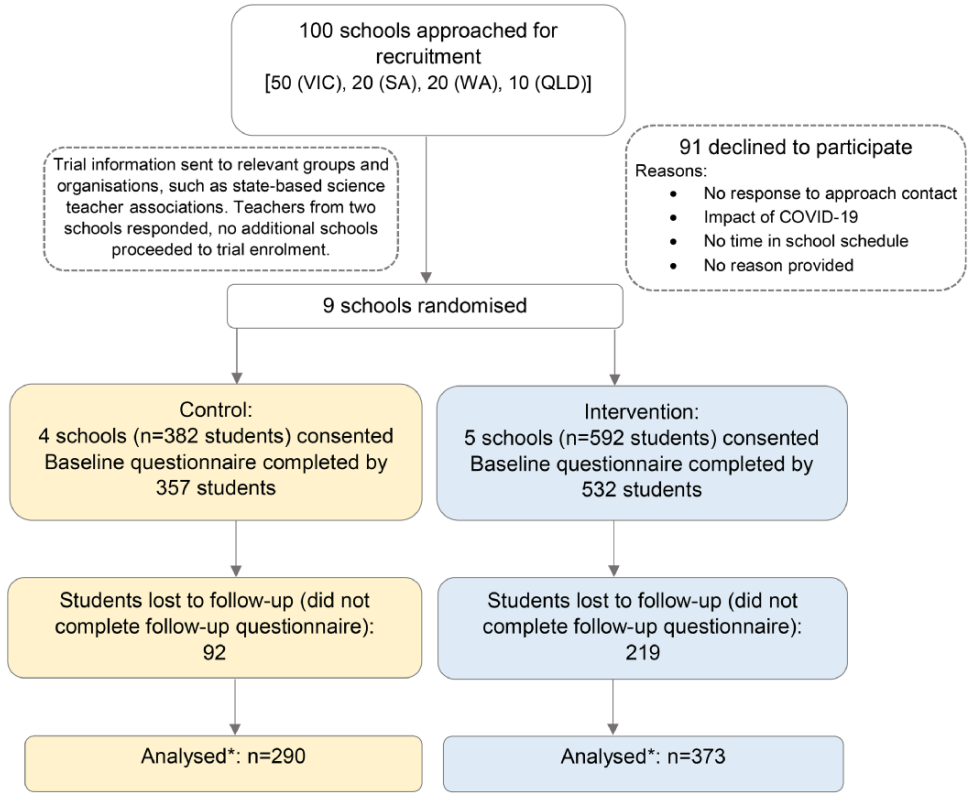

Fig. 1. Flow of participants through trial. * Sample size relates to the analysis of the primary outcome measure. There were more responses for some of the secondary outcome measures.

assessing claims (Qs 20 and 21), for which there were minimal between-group differences. Responses to the short answer questions (Qs 22.1–22.5) in which students had to appraise a health advertisement also revealed no between-group differences (Table IV). Table IV also shows a comparison of 'basic' or 'extended' understanding in responses to two of the short answer questions (22.4 and 22.5). In both groups, there was an increase from baseline to follow-up in the proportion of students who demonstrated either a 'basic' or 'extended' understanding. For one question (Q.22.5; which asked students to describe what information they would need for it be valid evidence), there was a greater increase, from baseline to follow-up, in the proportion of intervention students, compared with the control group, who demonstrated a basic understanding (increase of 43% versus 15.4%, respectively) or an extended understanding (5.95% versus 0.63%, respectively).

Satisfaction and feasibility

Figure 2 shows student satisfaction with the intervention. The majority reported that they trusted the information within the Health HACC programme (70.2%), found it easy/very easy (62.7%), found it helpful/very helpful (59.9%) and liked/liked the programme a lot (51.6%).

Teacher feedback

Twelve teachers from the intervention schools completed the teacher questionnaire. Ten teachers reported teaching all the modules, while two

Table I. *Student characteristics*

	Control group ($n = 382$)	Intervention group ($n = 592$)	Total ($n = 974$)
Age (years)			
<12	1 (0.3)	6 (1.0)	7 (0.7)
12	31 (8.2)	1 (0.2)	32 (3.3)
13	97 (25.4)	88 (14.9)	185 (19.0)
14	141 (36.9)	302 (51.0)	403 (41.4)
15	91 (23.8)	173 (29.2)	264 (27.1)
>15	12 (3.1)	4 (0.7)	16 (1.6)
Gender			
Male	139 (37.4)	216 (23.0)	355 (37.8)
Female	228 (61.3)	331 (58.4)	559 (59.5)
Others	5 (1.3)	20 (3.5)	25 (2.7)
Grade level			
7	51 (13.8)	1 (0.2)	52 (5.6)
8	122 (32.9)	127 (22.6)	249 (26.7)
9	166 (44.7)	431 (76.7)	597 (64.0)
10	32 (8.6)	3 (0.5)	35 (3.8)
Class subject in which the study was undertaken			
Science	217 (58.8)	560 (98.9)	777 (83.1)
Health education	39 (10.6)	1 (0.2)	40 (4.3)
Physical education	0	3 (0.5)	3 (0.3)
Others	113 (30.6)	2 (0.4)	115 (12.3)

Data are presented as number (percentage).

reported that not all modules were able to be taught but did not provide details about which. Overall, feedback indicated that the programme was well received and teachers felt that the topic was relevant, the programme offered sufficient content, the teacher guide was clear and useful, the information provided to teach the programme was sufficient and there was unanimous support for the inclusion of this type of education within the Australian high school curriculum. The main challenges reported with delivering the programme included adhering to the estimated time frames for the content and activities and maintaining student engagement throughout the programme. Decreased engagement was cited by some as contributing to delaying progression through the modules with the proffered reasons including too much content within some modules and the use of class discussion questions. External factors were also mentioned, such as the timing of programme delivery at the end of term and intercurrent event (COVID-19 pandemic) impacts on teachers and students. Supplement E provides further details on the teacher feedback.

Discussion

This randomized trial of an educational intervention to improve high school students' ability to identify and appraise claims about health interventions found only slight between-group differences for the primary or secondary outcomes. While an increase in the proportion of intervention students who achieved a mastery score was observed, statistical analysis of matched change data for the sample was not possible and no firm conclusion about this can be drawn.

For one of the open-ended questions that required students to appraise a health advertisement, a higher percentage of students in the intervention group, compared with those in the control group, displayed either a basic or extended understanding. Again, these outcomes were only able to be compared descriptively, limiting interpretation of this result.

Student satisfaction with the intervention was generally high, with the programme trusted by most students, the content considered 'easy' and 'helpful' and the program 'liked'. Teacher feedback revealed that different classes had different experiences, but overall, the content was considered relevant and useful, and the materials were clear and useful. Several teachers reported challenges regarding the estimated time frames for some content and maintaining student engagement for some topics. We were unable to assess the extent to which teachers understood the content and had sufficient knowledge and skills in the concepts being taught to teach them effectively.

Strengths and limitations

Strengths of the study include a cluster trial, randomized by schools to prevent contamination between students; a primary outcome measure that was rigorously developed, validated across several

Table II. *Baseline and follow-up score, and change scores for the primary[a] and secondary outcome measures (Claim questions) in both intervention and control groups*

Baseline scores					
Outcome (Claim score)	Control group $n = 357$	Intervention group $n = 532$	–	–	ICC
Total score (out of 25): mean (SE)	14.0 (0.66)	12.9 (0.58)	–	–	0.09
Pass % (≥13/25 correct)	59%	54%	–	–	0.05
Mastery % (≥20/25 correct)	11%	5%	–	–	0.06
Follow-up scores					
Outcome (Claim score)	Control group, $n = 290$	Intervention group $n = 373$	Mean difference or OR (95% CI)	*P*-value	ICC
Total score (out of 25): mean (SE)	13.6 (0.9)	14.4 (0.8)	0.8 (−1.6 to 3.1)	0.52	0.12
Pass % (≥13/25 correct)	54%	62%	1.4 (0.65 to 3.1)	0.38	0.06
Mastery % (≥20/25 correct)	13%	16%	1.3 (0.34 to 5.0)	0.69	0.17
Change scores (matched baseline and follow-up scores)					
Outcome	Control group, $n = 157$	Intervention, $n = 241$	Difference (95% CI)	*P*-value	ICC
Change score: mean (SE)	0.08 (0.75)	1.3 (0.59)	1.2 (−0.7 to 3.1)	0.21	–

[a]The primary outcome is the mean total score. SE = standard error.

countries [24, 26] and enabled selection of relevant items and an iteratively developed intervention. There are several limitations though. The sample is likely not representative of the Australian high school population as only independent schools participated. Although the total number of students (974) exceeded our sample requirement (minimum of 720 students), the target number of schools (12) was not reached, and three of the recruited schools did not meet the assumption of 60 students per school. Recruitment was much more difficult than anticipated, primarily due to the intercurrent events (COVID-19 pandemic) which began a few weeks after recruitment began. The intercurrent event impact included massive disruption to schooling (and inability for the trial to be conducted as part of online schooling); school and teacher burnout and low enthusiasm and diminished time available to participate due to schools' frequent rescheduling of curriculum as lockdown rules changed. Loss to follow-up was high across both groups with many students not completing the follow-up questionnaire. This mostly occurred due to the absence on the day of the follow-up assessment, usually because of illness or isolation, including from COVID-19, or leaving early for holidays as many schools conducted the follow-up assessment in the final week of term. The selection of question items from the Claim Evaluation Tools database utilized within the test has not been tested in other populations of a similar age, and thus, the assessment may have lacked sensitivity.

Table III. *Baseline and follow-up results for intended behaviours, self-efficacy and attitudes towards assessing health claims in both intervention and control groups*

Questions		Control % likely or very likely	Intervention % likely or very likely	Odds ratio[a] (95% CI)	*P*-value
20 Think about an illness that you might get. Imagine someone claiming (saying) that a particular health intervention might help you get better.					
20_1 How likely are you to find out what the claim was based on (e.g. by asking the person making the claim)?	Baseline	35	40	1.22 (0.64, 2.33)	0.55
	Follow-up	28	30	1.10 (0.63, 1.92)	0.75
20_2 How likely are you to find out if the claim was based on a research study comparing the intervention group to no intervention (e.g. a control group)?	Baseline	41	44	1.11 (0.69, 1.79)	0.66
	Follow-up	39	38	0.94 (0.69, 1.30)	0.72
21 How difficult or easy would you find each of these actions to be?					
21_1 Assessing whether a claim about a health intervention is based on a research study comparing an intervention with no intervention (e.g. an intervention group versus a control group).	Baseline	32	27	0.81 (0.54, 1.20)	0.29
	Follow-up	31	33	1.13 (0.63, 2.01)	0.68
21_2 Assessing where I can find information about interventions that is based on research studies comparing an intervention with no intervention.	Baseline	34	31	0.88 (0.46, 1.66)	0.69
	Follow-up	28	32	1.23 (0.65, 2.33)	0.53
21_3 Assessing how sure I can be about the results of a research study comparing interventions.	Baseline	37	39	1.09 (0.59, 2.03)	0.78
	Follow-up	39	37	0.92 (0.43, 1.94)	0.82
21_4 Assessing if the results of a research study comparing interventions (e.g. an intervention group versus a control group) are likely to be relevant to me.	Baseline	41	39	0.92 (0.50, 1.66)	0.77
	Follow-up	40	41	1.03 (0.62, 1.73)	0.90

[a]Likely or highly likely compared with unlikely, highly unlikely, do not know, missing.

Deeper insights into the findings and response to the intervention may have been obtained by conducting a process evaluation, including structured observations and interviews.

Analysis of change scores for each student as the primary analysis was hampered due to a large proportion of questionnaires, for which baseline and follow-up responses could not be matched. Anecdotal feedback from teachers was that some students were not motivated to complete the questionnaire or attempt it sincerely as the questions were not part of school assessment and were completed anonymously, and there were no consequences for non-completion or providing non-genuine responses. The impact of students' attitude to the intervention, and the questionnaires, may have contributed to the lack of a larger effect. Other contributing factors could have included that the program content was new for teachers, programme delivery was sometimes rushed with insufficient time to consolidate the content, a perception that the programme did not matter as it was not part of the formal curriculum and COVID-related weariness and exhaustion in teachers and students. These challenges are common barriers to teaching, and evaluating, interventions to improve health education in schools, particularly for topics that are beyond the traditional academic subjects [29]. Fidelity of the intervention was not formally assessed, thus it is unknown whether teachers who taught the content understood the concepts and taught them accurately, to what extent teachers

Table IV. *Health advertisement appraisal skills—between-group analysis*

Questions		Control % correct	Intervention % correct	Odds ratio (95% CI)	*P*-value
22_1 What is the health intervention being discussed?	Baseline	39	29	0.63 (0.32, 1.23)	0.18
	Follow-up	34	23	0.59 (0.26, 1.32)	0.20
22_2 What is the claimed outcome?	Baseline	40	36	0.84 (0.39, 1.81)	0.65
	Follow-up	44	48	1.17 (0.45, 3.00)	0.75
22_3 Which type/s of information is/are being provided as 'evidence' of the effectiveness of the health intervention in the advertisement above?	Baseline	36	27	0.67 (0.36, 1.24)	0.20
	Follow-up	39	25	0.53 (0.23, 1.25)	0.15
22_4 Are you convinced by these health claims? Why or why not? Justify your response.	Baseline	44	33	0.61 (0.23, 1.66)	0.33
	Follow-up	57	42	0.55 (0.21, 1.48)	0.24
22_5 What kind of information would potentially convince you that the information is valid?	Baseline	24	19	0.76 (0.27, 2.12)	0.60
	Follow-up	36	33	0.89 (0.34, 2.31)	0.81
Basic understanding					
22_4 Are you convinced by these health claims? Why or why not? Justify your response.	Baseline	(155/303) 51.6	(210/402) 52.2		
	Follow-up	(175/247) 70.9	(183/260) 70.3		
22_5 What kind of information would potentially convince you that the information is valid?	Baseline	(79/288) 27.4%	(93/398) 23.4%		
	Follow-up	(104/243) 42.8	(156/235) 66.4		
Extended[a] understanding					
22_4 Are you convinced by these health claims? Why or why not? Justify your response.	Baseline	(2/303) 0.66	(0/402) 0		
	Follow-up	(3/247) 1.21	(5/260) 1.92		
22_5 What kind of information would potentially convince you that the information is valid?	Baseline	(3/288) 1.04	(0/398) 0		
	Follow-up	(1/243) 0.41	(14/235) 5.96		

[a]Responses that indicated a deeper understanding of key concepts by providing elaboration beyond a basic reason, including specific information about the misleading information in the advertisement and/or the type of information needed to improve the claim's validity.

followed the teaching guide and PowerPoint slides, how much of the total content was delivered from each of the different topics or how well it was delivered.

The primary outcome measure assessed the ability to apply the concepts that the resources were designed to teach, thus this study used a treatment inherent outcome measure. These types of measures are associated with larger effect sizes than treatment-independent measures. Also, there was more attrition in the intervention schools (37%) than in the control schools (24%). However, it is difficult to determine whether this introduced attrition bias and, if it did, in which direction. Our sample size calculation did not account for the potential loss of cluster(s), which would have further reduced the power of our trial if that had occurred.

There are few similar studies against which our findings can be compared. To our knowledge, there are no other randomized controlled trials in adolescents comparing an educational intervention with no intervention. Neither the systematic review by Nordheim *et al.* [15], which examined

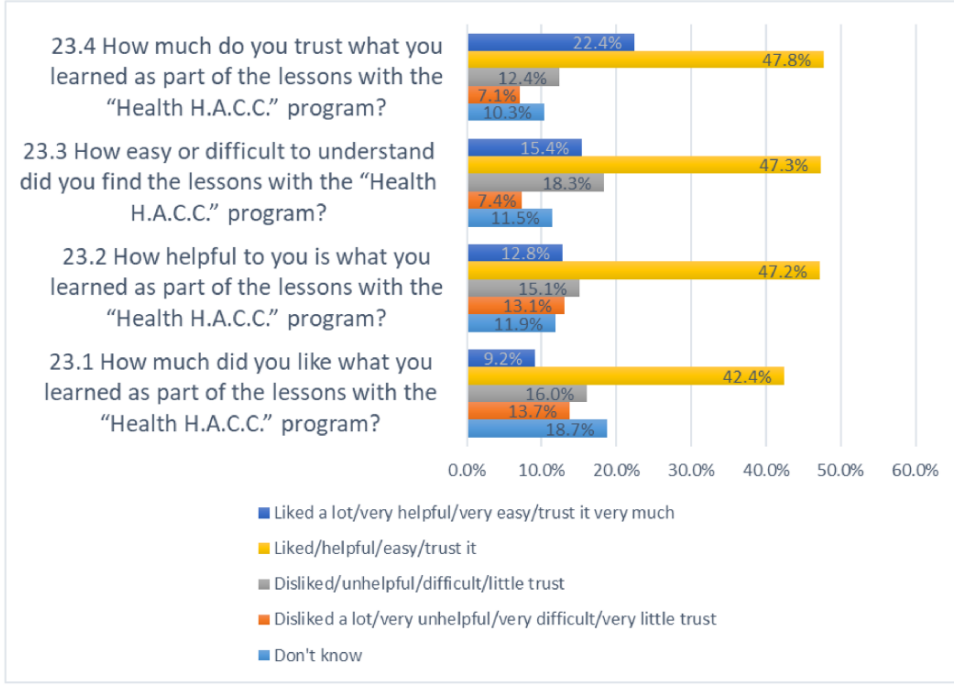

Fig. 2. Students' satisfaction with the intervention.

school-based educational interventions for adolescents, nor our systematic review of educational interventions for the general public that we performed prior to developing the intervention [13], identified such a trial.

The most similar trial is the IHC cluster randomized controlled trial in primary school students by Nsangi *et al.* [23]. They evaluated an educational intervention (teacher-led delivery of content with a teacher's guide and cartoon book for students) and found an improvement in the ability of children in the intervention group, compared with the control group (mean score 62.4% for intervention schools compared with 43.1% for control schools, adjusted mean difference 20.0%, 95% CI 17. 3–22. 7; $P < 0.00001$), to assess claims about the effects of treatments, measured using items from the Claim Evaluation Tools database. However, numerous differences between their study and ours may help to explain the different findings: the target population was children in primary school (Grade 5, aged 10–12); the study had support from the region's Ministry of Education and district education officers assisted with recruitment, helping them to achieve a very large sample size (120 schools, including a high proportion [>50%] of public schools) which may have also influenced how seriously the study was taken by teachers and students; fewer problems with completeness of data, with the proportion of missing values (unanswered questions) for each question ranging from 0.5% to 4.3%; low loss to follow-up, with the study achieving 90% of tests completed in the intervention group and 71% in the control group; participating teachers were invited to a 2-day preparatory workshop and the intervention was delivered over 9 weeks for 80 min per week (total of 11 h).

In contrast, our study involved a much smaller sample size, lacked public school participation, had a high proportion of missing data, had a less intensive intervention (approximately 3.5 h), was unable to require advanced preparation from participating teachers and was conducted during a pandemic that greatly impacted school delivery. The impact on results from the present study involving adolescents, in which attitudes towards school work and assessment that is not compulsory may differ from primary school students, is also unknown. An updated search of the literature using the same strategy as the systematic review by Cusack *et al.* [13] did not identify any additional published randomized trials [30]. We are aware of trials assessing an intervention in high schools in East Africa, although results are not yet published [31–33].

Implications and future research

While the feedback from the students and teachers about the programme was generally positive, the effect of the intervention is not clear. Components of high school curriculum are rarely tested in trials, and given the generally positive feedback, the programme (or similar) could be made available and used by schools or teachers as they desire. The teacher feedback included comments from some about insufficient time to complete the modules. Hence, a revised programme should either have an increased total duration of the programme or have a reduction in the number of concepts that are covered.

The test (questionnaire) used within this research, and the passing and mastery cut-off scores, was not validated in the context of Australian high school students, and this is recommended as an area of future research. Given the issues with missing data, we recommend requiring a response for each test question before progression to the next, although this does not safeguard against random guesses.

The challenges faced with matching the unique codes impeded our ability to match many of the responses. It was not clear why the coding system failed, as it was successfully used when we piloted the intervention and evaluation measures. For future research, we recommend that a robust method which ensures that baseline and follow-up data can be matched is developed. For example, this may be achieved through collaboration with the curriculum authorities and school personnel to match the data using student numbers (while remaining anonymized to researchers).

Even though almost two-thirds of the intervention students considered that the programme was easy or very easy, and only 62% of them achieved a pass mark and 16% a mastery score, this may reflect a lack of engagement with the content, the non-compulsory nature of the programme and not taking the intervention, or the assessment, seriously. If further trials of this, or similar, interventions are conducted, suggestions for improvement include obtaining support from, and possible collaboration with, education departments and/or curriculum authorities [29, 34], the inclusion of public schools, ensuring methods of matching baseline and follow-up data and confirmation of sensitivity of the assessment with a similar population. Further research that would be valuable includes evaluating an altered version of the intervention (e.g. length, delivery mode and teaching methods) and measuring behaviour change as an outcome.

Conclusion

With such a pervasive presence of health information and misinformation, helping students to develop skills to identify and critically appraise health claims is imperative. While students and teachers generally reported a positive experience with the Health HACC programme in this trial, and although limitations occurred throughout the trial which prevented planned analyses, it is unlikely the intervention had a large effect.

Supplementary data

Supplementary data are available at *HEAL* online.

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Author contributions

L. Cusack (Methodology, Investigation, Formal analysis, Data curation, Writing—Original draft), M. Jones (Formal analysis, Data curation, Writing—Review & Editing), L. Desha (Investigation, Formal analysis, Data curation, Writing—Review & Editing) and T. C. Hoffmann (Conceptualization, Methodology, Resources, Investigation, Data curation, Supervision, Writing—Review & Editing)

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