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A quasi-experimental text messaging trial to improve adolescent sexual and reproductive health and smoking knowledge in Indonesia

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Abstract. ***Background*:** To evaluate the feasibility and acceptability of a text message intervention to improve young people's knowledge of sexual reproductive health (SRH) and harms related to smoking in Indonesia. ***Methods*:** A quasi-experimental short message service (SMS) trial of young people aged 16–24 years receiving twice weekly SMS over a 10-week intervention period. Pre- and post-online demographic and risk behaviour surveys were used to assess changes in knowledge. Among respondents who completed both surveys, we assessed changes in knowledge before and after SMS intervention using paired McNemar's test and differences in mean knowledge score using a paired *t*-test. ***Results*:** In total, 555 eligible young people were enrolled into the SMS intervention; 235 (42%) completed a follow-up survey, of which 198 (84%) were matched to a baseline survey. Median age of participants was 19 years and the majority were female (63%). The mean knowledge score significantly increased between baseline and follow-up surveys for SRH questions [2.7, (95% CI 2.47, 2.94) vs 3.4 (95% CI 2.99, 3.81) (P = <0.01)] and smoking-related questions [3.8 (95% CI 3.66, 3.99) vs 4.1 (95% CI 3.99, 4.28) (P = 0.03)]. A majority of participants reported that the SMS intervention increased their knowledge (95%) and were a useful reminder (95%). ***Conclusions*:** An SMS intervention was feasible, acceptable and improved adolescents' SRH knowledge and smoking knowledge in a low- to middle-income setting. SMS interventions targeting young people need to be scaled up, with the potential to explore additional topics around healthy lifestyle, nutrition and physical activity.

Additional keywords: adolescent health, health promotion, mobile phone.

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Introduction

With a population of over 261 million people, Indonesia is the fourth most populous country in the world and the largest economy in South East Asia.[1] The population is increasingly urbanised and young, with more than 65 million young people aged between 10 and 24 years, representing ~25% of the total population.[2]

A lack of access to sexual and reproductive health (SRH) information and services for young Indonesians (males and females), particularly unmarried young people, is a significant public health problem.[3–6] It is estimated that 32 000 Indonesian women experienced unwanted pregnancies between 2010 and 2014.[7] While this is largely thought to be due to unmet need for family planning services,[8] particularly for young people, shifting attitudes and behaviours regarding sexuality and sex outside marriage for young people is thought to be also contributing this this trend.[4,9,10] Under-utilisation of SRH services by adolescents and the exclusion of SRH education

and services for unmarried young people further exacerbates these issues.[4,11,12] Another contributing factor are the social and religious customs in Indonesia, which mean that sex remains a taboo subject that is not openly discussed,[12] and sex outside marriage is heavily stigmatised.[13] In addition, providing reproductive health information and services to single young people is still controversial, and while there is growing support for public campaigns and interventions designed to do so,[4,14] public campaigns and education in schools may cause significant anxiety for young people who are sexually active and may serve to create further barriers to accessing health services. For these reasons, Indonesian married youth and unmarried youth are faced with different problems.[4,5,15]

Gender also plays an important part in tobacco use in Indonesia; the prevalence of smoking among males and females aged ≥15 years in 2016 were 67.0% and 3.0% respectively.[16] These data suggest that men are 22.3-fold more likely to smoke compared with women. Recent studies[6] found that among Indonesians aged 13–15 years, 21.4% of boys and 1.5% girls were smoking cigarettes, while among those aged 15–19 years, 74.4% of males and 8.9% of females reported smoking tobacco, and that daily exposure to second-hand smoking in households was high (64%).

Several factors may explain the high prevalence of smoking among males, including being the fifth-largest producer of tobacco globally,[16,17] aggressive and innovative marketing strategies by tobacco companies[18] and weak tobacco control measures and regulations that enable the affordability and widespread accessibility of cigarettes.[16,17,19,20] The average price of *kretek* (locally made cigarettes infused with cloves) is IDR12 699 per 20 sticks, which is approximately USD 1.[21] Previous studies[19,22] have identified gaps in young adolescent's knowledge about health risks caused by smoking and related outcomes. One study assessing the effect of written health warnings on smoking packs among participants from two districts in Java (Jakarta and Cirebon) found that while 90% of smokers read the warning, just under half (42.5%) believed that the health problems would affect them.[23] It recommended that health promotion programs focus on changing and improving the community awareness and attitudes towards passive smoking and intensify health education to students and communities with low socioeconomic status.

In 2016, Indonesia's youth literacy rate among 15- to 24-year-olds was 99.67%,[24] highlighting the potential to engage this population in health promotion and education. In addition, the growing prevalence of Internet use or smartphone ownership provides further opportunities for utilising these platforms for education and health interventions. The rapid rise in mobile-cellular subscriptions from 87 in 2010 to 147 per 100 inhabitants in 2016, and with ~70% of Indonesians aged 14–24 years having access to a mobile phone,[25] highlights the potential reach of mHealth interventions well beyond anything possible using traditional media. mHealth applications have been shown to be cost-effective for a range of preventive health priorities, including smoking,[26] HIV/AIDS[27,28] and SRH and maternal health services.[29,30] Short message service (SMS) is a service available on most digital mobile phones, and SMS interventions to date have shown impact on SRH and smoking in both high-income[31–33] and low-income countries.[34–36] With its large youth population, unmet need for family planning services and high rates of smoking, our objective was to determine the feasibility and acceptability of a tailored SMS intervention to increase knowledge and awareness of sexual and reproductive health and harms related to smoking among adolescents in Indonesia.

Methods

Participants

The study population included individuals aged 16–24 years residing in the district of Salatiga (Central Java), an urban setting with ~176 000 population located in between two large cites of Semarang and Yogyakarta. Participants were recruited from nine locations; two large high schools, one large university and six community health facilities (puskesmas), with the aim to recruit a sample of young people with a mix of risk profiles to assess the feasibility and acceptability of an SMS intervention. Salatiga was selected based on key characteristics including, peri-urban geography, high population of young people (due to several large universities) and high rates of youth pregnancy, low levels of access to family planning services and high rates of youth smoking.[3] Study sites were purposively selected based on population size, with the largest schools and universities selected for inclusion. Community health facilities sites were then selected based on close proximity to the selected schools and universities and also if they had any youth-focussed programs.

Intervention design

This study was designed as a quasi-experimental pretest–posttest trial, to assess the feasibility and acceptability of sending young people aged 16–24 years twice-weekly unidirectional educational and persuasive text messages over a 10-week period. Pre- and post online evaluation surveys were used to collect demographics and risk behaviour information, which informed the SMS schedule they received, and was used to assess changes in knowledge between and within individuals and intervention acceptability.

To improve acceptability of the SMS intervention, text messages were developed by the authors and project staff in a formative study involving focus group sessions with youth aged 16–24 years from Salatiga (Project 271/13); this was also informed by previous sexual health promotion projects.[32,37] The formative study revealed a reticence from both the ethics committee and the youth participants to send unmarried participants messages about how condoms can prevent pregnancy, as they felt this was culturally inappropriate as it was seen as promoting premarital sex. Accordingly, messages were developed for specific target groups segmented by gender, marital status and smoking status to ensure the messages were relevant and culturally appropriate. Messages included a mix of informational, persuasive and factual health messages that also promoted health services or websites available to youth. Each participant received 12 intervention SMS plus additional reminders at recruitment and follow up with links to the evaluation surveys (Appendix 1).

Intervention implementation

Participants were recruited in person, face-to-face through schools, universities and local health facilities. Study researchers set up a small stall at convenient times (0900 hours – 1400 hours) for 2–3 consecutive days at each recruitment site and promoted the study and recruited participants. For youth aged under 18 years, parental consent was obtained before collecting participant assent, while for those aged ≥18 years, consent was directly provided. Following consent, participant's contact details including name, mobile phone number, gender and date of birth were collected and used to enrol them into the relevant SMS schedule based on their risk profile. They were offered the opportunity to complete a baseline evaluation survey (online or face-to-face).

A custom-built SMS gateway system (Gammu v.2, Gammu, Boston, MA, USA) was built for the purpose of this study, which managed all the SMS sending and any bouncing of messages, and allowed participants to text 'STOP SMS4HEALTH' to be unsubscribed from the intervention. Enrolled participants received an initial welcome message with links to the baseline survey, followed by a series of 12 intervention messages, two per week delivered at the same time of the day. An example of a message broadcast schedule is displayed in Appendix 1. Following the intervention, participants were also invited to complete a follow-up survey (online only) and given the opportunity to attend a focus group to provide feedback on the intervention. The evaluation survey was informed by previous youth health surveys developed in Indonesia.[10,17,38] Participants were given USD $2.50 worth of e-credit for their mobile account for completing each evaluation survey. Five focus groups ($n = 34$ participants) and two in-depth interviews were conducted with participants split into groups based on gender, age (16–19 and 20–24 years) and marital status, to further explore message acceptability, persuasiveness of the message and feasibility of scale up.

Outcome measures

To assess feasibility, we examined rates of screening, recruitment, retention and opt-outs (unsubscriptions) and text message delivery rates, as reported by our SMS gateway system. To assess acceptability, we asked participants questions relating to the number of messages received and acceptability of the health messages. We reclassified the SMS acceptability questions as 'Strongly Agree/Agree' and 'Neither agree nor disagree/Disagree/Strongly disagree'. To assess changes in knowledge, we asked the same six sexual health-related knowledge questions and seven smoking-related knowledge questions (true/false/don't know response) at baseline and again at follow up. The sexual health questions covered a range of topics including sexually transmissible infection (STI) transmission/symptoms, contraceptives, antenatal care visits and the legality of medical abortions. The smoking-related knowledge questions covered facts around the toxins contained within tobacco, tobacco exposure, basic health risks due to smoking and potential effects of passive smoking and benefits of quitting smoking, including one inverse question 'passive smoking carries more health risk than active smoking'. To further explore potential efficacy of the intervention, we examined a potential dose–response relationship between changes in SRH and smoking-related knowledge scores and the number of text messages participants self-reported receiving over the intervention period (SMS dose) and whether participants reported a positive benefit from participating in the study, either having 'Learnt something new', 'Found the SMS informative' or 'Found the SMS interesting'.

Sample size

We aimed to recruit ~200 participants from each study location type (high school, university and community health facility), with a total of ~600 to allow us to assess acceptability and feasibility of recruiting young people from community locations and measure changes in knowledge, stratified by risk profiles (gender, marital status and smoking status).

Statistical analysis

Analyses were undertaken using Stata 14.2 (StataCorp, College Station, TX, USA). P values of <0.05 were regarded as statistically significant and 95% confidence intervals were reported (as applicable). Descriptive statistics were used to report respondent characteristics, risk- and health-seeking behaviours and knowledge. To assess potential selection bias among those who completed the follow-up survey, we compared demographic characteristics of participants who did complete the follow-up survey with those that did not complete the follow up, using χ^2 tests. χ^2 tests were used to assess differences in baseline knowledge and risk practices among risk profile groups (males/females, married/unmarried, smoking/non-smoking) and independent samples t-tests were used to compare baseline mean knowledge scores.

Follow-up data were analysed and compared with baseline data. Among respondents who completed both the baseline and follow-up surveys, we assessed changes in each of the 13 knowledge components separately (six SRH and seven smoking-related messages) by comparing the proportion correctly answering each question at baseline and follow up using a paired McNemar's test of proportions. Then, for each survey, we created a composite knowledge score for the SRH components (maximum score of six) and smoking-related components (maximum score of seven) – each correct answer was allocated one point; incorrect or missing answers were allocated zero points. Differences in mean knowledge score for SRH components and smoking-related components were assessed using paired (samples) t-tests.

To further explore potential efficacy of the intervention, we examined a potential dose–response relationship between a positive change in knowledge between baseline and follow up with receiving a high SMS dose and reporting a positive benefit from participating in the SMS study, using logistic regression. We classified self-reported SMS dosage as *low* if participants reported receiving between 5–11 SMS health messages and *high* if participants reported receiving ≥12 SMS health messages. We categorised the outcome by

calculating the direction of the change in knowledge scores between baseline and follow-up surveys into two groups:

- Negative Change/No Changes: if the follow-up knowledge score was lower or the same as the baseline knowledge score; and
- Positive Change: if the follow-up knowledge score was higher than the baseline knowledge score.

All results were also adjusted for potential confounding factors identified *a priori* (age group, gender, marital status and smoking status). The Hosmer–Lemeshow goodness of fit test was used to assess each model fit.

Ethics

Ethics approval was provided by the Universitas Gadjah Mada Human Research Ethics Committee in Indonesia, the Alfred Hospital Human Research Ethics Committee in Australia and the Research Triangle International Internal Review Board in the USA.

Results

Recruitment and feasibility

We approached 958 participants across the three recruitment venues and 581 (61%) young people provided contact details and completed a baseline survey. Of the 581 recruited, 555 (96%) were deemed eligible and enrolled into the SMS intervention, with one participant aged <18 years who failed to provide parental consent and 25 participants who were aged >24 years. Based on participants' profile, we segmented participants into eight separate risk groups; however, a majority of participants recruited were either unmarried, female and non-smokers (59%), unmarried, male and non-smokers (25%) or unmarried, male and smokers (11%) (Table 1). All participants were then sent 12 interventions SMS; one SRH- and one smoking-related message per week based on their risk profile. At the end of the intervention period, 235 (42%) participants completed the follow-up evaluation survey, of which 198 were successfully matched to their baseline survey and were included in a pretest–posttest analysis (Fig. 1). Overall, only one patient withdrew from the study.

Participant characteristics

Table 1 details participant characteristics. Among the baseline sample, the median age of participants was 19 years, 63% were female, 5% had ever been married, 10% reported ever having sex and 11% reported being a current smoker. Compared with participants who completed a follow-up survey, participants who did not complete a follow-up survey were significantly more likely to be older (20–24 years, $P = 0.01$), recruited from university or a health facility ($P = 0.01$) and a current smoker ($P < 0.01$).

Sexual risk practices, health-seeking behaviour and knowledge at baseline

At baseline ($n = 555$), a significantly higher proportion of males (17% males vs 7% females, $P < 0.01$) and married participants

Table 1. Characteristic of participants who completed baseline and follow-up surveys

SMS, short message service

	Baseline		Follow up	
	n	%	*n*	%
Total	555	100.0	235	100.0
Gender				
Male	204	36.7	82	34.9
Female	351	63.2	153	65.1
Median age	19		18	
Age range (min-max)	16–24		16–24	
Age (years)				
16–19	388	69.9	178	75.7
20–24	167	30.1	57	24.3
Employment				
Attending school/university	444	80.0	202	86.0
Attending school/university and working	57	10.3	16	6.8
Other (working, home/farm/ business)	54	9.7	17	7.2
Highest education				
< Junior High School	107	19.2	80	34.1
Senior High School	402	72.4	133	56.6
Academy/University	46	8.3	23	9.8
Religion				
Islam	302	54.4	139	59.2
Protestant	188	33.9	75	31.8
Catholic	57	10.3	19	8.1
Other (Buddhist, Agnostic)	8	1.4	2	1.0
Ever had sex	58	10.4	25	10.6
Median age of first sex (years)	17.8		18.4	
Marital status				
Single/Unmarried	526	94.8	242	95.3
Ever married[A]	29	5.2	11	4.7
Smoking status				
Current smoker	71	11.4	15	6.8
Non-smoker	484	88.6	220	93.2
Do you have children?				
No	533	96.0	225	95.7
Yes	22	3.9	10	4.3
Are you planning to have children in the next 12 months?				
No	541	97.5	229	97.5
Yes	14	2.5	6	2.6
Recruitment site	$n = 555$		$n = 198$[B]	
High-school venues	138	24.9	85	43.5
Universities	342	61.6	96	48.4
Local health facility	75	13.5	15	15.3
SMS intervention group				
Group A: Unmarried, Male, Smoker	60	10.8	12	6.0
Group B: Unmarried, Female, Smoker	5	0.9	1	0.5
Group C: Unmarried, Male, Non-Smoker	137	24.8	52	26.3
Group D: Unmarried, Female, Non-Smoker	328	59.1	125	63.1
Group E: Married, Male, Smoker	5	0.9	1	0.5
Group F: Married, Female, Smoker	1	0.2	0	0
Group G: Married, Male, Non-Smoker	3	0.5	2	1.1
Group H: Married, Female, Non-Smoker	16	3.0	5	2.5

[A]Ever married included currently married, divorced and separated.
[B]Restricted to participants who completed both baseline and follow-up survey that could be matched.

(86% married vs 6% unmarried, P <0.01) reported ever having sex. Inconsistent condom use was common (>80%), slightly higher among females (95% females vs 85% males, P <0.21) and among married participants (100% married vs 82% unmarried, P <0.03). Among those sexually active, only a small proportion of participants reported having ever been tested for HIV/STIs (26%), slightly higher among females than males (26% vs 17%, P <0.24), although this was not significant. Most participants reported accessing SRH health information through Internet/media (78%) or through a health provider/trained peer (57%), yet only 28% reported having visited any of the six reputable websites developed for Indonesian youth in the past 3 months. The mean sexual health knowledge score at baseline was 2.6 out of 6 (43%), which was similar between males and females and between age groups, but it was significantly higher among married participants compared with unmarried participants (3.5 vs 2.5, P <0.01; Table 2).

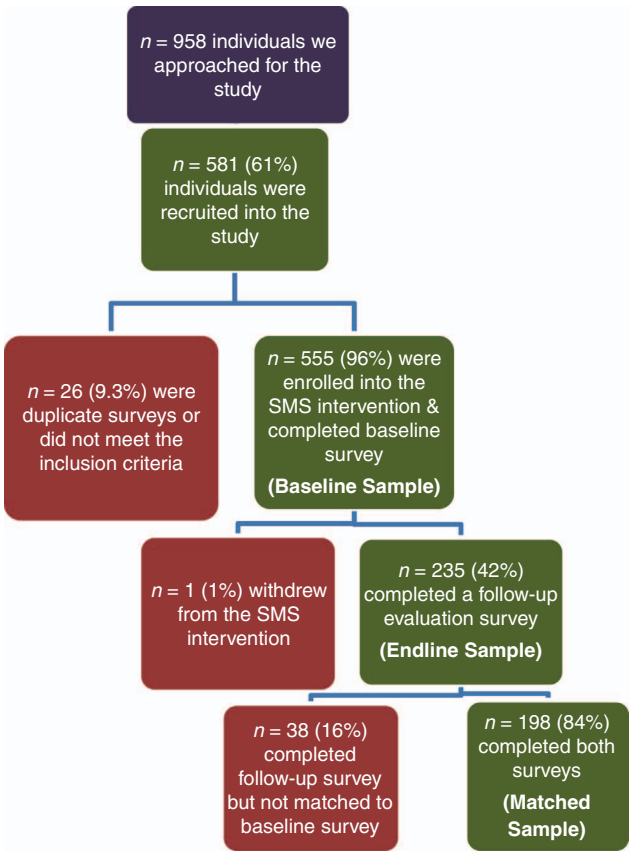

Fig. 1. Participant flow chart.

Smoking status, health-seeking behaviour and knowledge at baseline

At baseline (n = 555), over one-quarter of the sample (28%) reported having ever tried smoking, significantly higher among males than females (62% vs 9%, P <0.01), yet both groups reported similar mean age of smoking their first cigarette (14 years). Among current smokers (n = 71, 11.4%), the majority were regular smokers (56% reporting having smoked >11 days in the past month) and smoked less than a pack a day (84%). The mean knowledge score for smoking was 3.7 out of 7 (53%), which was similar between male and females, age groups and current and non-smokers (Table 2).

SMS acceptability

Among the 235 participants who completed the follow-up survey, acceptability of the SMS intervention was high with, 95% (222/235) reported that they learnt something from the SMS, and that the SMS messages were informative and a useful reminder, while 61% (143/235) reported the SMS messages were interesting or entertaining. Of the total of 6660 SMS

Table 2. Comparison of baseline knowledge scores of participants by risk profile (n = 555)
Bold indicates statistical significance

Knowledge scores	Mean score	95% CI	Mean score	95% CI	P value
SRH knowledge score by gender	Male		Female		
	n = 204	100	n = 350	100	
	2.7	(2.4 – 2.9)	2.5	(2.4 –2.7)	0.43
SRH knowledge score by marital status	Unmarried		Married		
	n = 526	100	n = 29	100	
	2.5	(2.4 – 2.7)	3.5	(2.9 –4.1)	**<0.01**
SRH knowledge score by age group	16–19 years		20–24 years		
	n = 288	100	n = 167	100	
	2.5	(2.3 – 2.7)	2.8	(2.5 –2.7)	0.09
Smoking knowledge score by gender	Male		Female		
	204	100	351	100	
	3.7	(3.5–3.9)	3.7	(3.6–3.8)	0.87
Smoking knowledge score by smoking status (current)	Non-smoker		Current smoker		
	492	100	63	100	
	3.7	(3.6–3.8)	3.5	(3.1–3.9)	0.30
Smoking knowledge score by age	16–19 years		20–24 years		
	388	100	167	100	
	3.7	(3.6–3.8)	3.7	(3.5–3.9)	0.96

messages sent during the intervention period (555 participants × 12 health-related text messages), the SMS gateway registered that only 71 (1%) SMS messages bounced back. Over half (138/235: 59%) of follow-up participants reported receiving SMS messages about both sexual health and smoking topics, over one-third (84/235: 36%) reported that they received the full dose of 12 messages, while (99/235: 42%) reported that they received a partial dose of 5–10 SMS messages.

Data from the focus groups indicated that while participants felt that the SRH messages were acceptable, informative, inoffensive, relevant and easy to understand, some unmarried participants felt uncomfortable receiving messages that they felt promoted extramarital relationships, while some married female participants reported conflict with messages about the safety of family planning methods, which were challenged by personal experiences and noted side-effects of different contraceptive methods. Participants reported that they preferred the tobacco control messages compared with SRH messages, and reported learning something new about the harmful effects of passive smoking. Young people identified additional health topics that they felt were important to target with health promotion messages, including personal hygiene, nutrition and healthy lifestyles.

Changes in knowledge between baseline and follow up

We assessed changes in each of the 13 knowledge components separately among the 198 participants who completed both a pre- and post-evaluation survey. There was a significant increase in the proportion correctly answering three of the six SRH questions at follow up, including medically necessary abortions being legal in Indonesia (47% baseline vs 62% follow up, $P = 0.02$), that you can have an STI without showing any symptoms (43% baseline vs 57% follow up, $P = 0.01$) and that condoms can prevent unwanted pregnancy and protect against STIs/HIV (62% baseline vs 79% follow up, $P = 0.04$) (Fig. 2). Similarly, there was a significant increase in the proportion correctly answering two of the seven questions about harms related to smoking questions at follow up, including that most tobacco smoke contains more than 7000 chemicals, hundreds of which are toxic and carcinogenic (66% baseline vs 77% follow up, $P = 0.01$) and that 12 h after smoking almost all of the nicotine will be out of your system (6% baseline vs 15% follow up, $P < 0.01$) (Fig. 2). Overall, the mean knowledge score for all SRH questions significantly increased between baseline and follow-up surveys from 2.7 (95% CI 2.47, 2.94) to 3.4 (95% CI 2.99, 3.81; $P < 0.01$) and for all smoking-related questions from 3.8 (95% CI 3.66, 3.99) to 4.1 (95% CI 3.99, 4.28; $P = 0.03$).

We then explored associations between changes in knowledge scores and self-reported having received a high dose of the SMS intervention (≥12 messages) and reports of positive benefits from participating in the SMS study, using logistic regression adjusted for key covariates. We found a significant association between 'reporting that they learnt something new' from the SMS intervention and an increase in SRH knowledge between baseline and follow-up surveys even after adjusting for age group, marital status and gender; however, wide confidence intervals are indicative of small sample sizes across groups (Table 3). Interestingly, we witnessed a similar increase in knowledge among participants reported receiving both high or low dosages of the SMS messages.

Discussion

To the best of our knowledge, this is the first community-based SMS prevention intervention using mobile technology targeting young people in Indonesia. The intervention was feasible, as evidenced by the large sample of over 500 young people recruited into the intervention and the low withdrawal rate across the intervention period (1% withdrawal rate). This study was able to show improvements in knowledge between baseline and follow-up surveys for three SRH health topics and two smoking-related topics, including sensitive topics of medical abortions and condom use, which can to prevent unwanted pregnancies; these are rarely covered in existing SRH education programs in Indonesia.[39] We were also able to show improvements in knowledge about the harmful effects of both smoking and passive smoking, and promote the positive effects of quitting smoking. Overall, the study showed a significant increase in the mean knowledge score for both SRH and smoking components; and supportive evidence of potential intervention efficacy, with significant associations between increases in SRH knowledge and participants reporting 'that they learnt something new' from the SMS intervention: a promising result.

While the study aimed to deliver messages tailored to participants' specific risk profile (smoking status, marital status and gender) to improve message relevance and acceptability, the low recruitment of participants into the married and smoking risk groups limited our ability to appropriately assess outcomes among these sub-groups (Table 1). However, distinct differences in risk practices, health-seeking behaviours and baseline knowledge among the different risk groups supported the need to segment audiences and tailor messages. The importance of tailoring messages was further highlighted in the focus group data, where participants expressed concern and a level of discomfort with receiving messages that they felt promoted extramarital relationships, which was at odds with their religious beliefs and cultural norms. Future studies should aim to improve the ability to deliver messages that are tailored, appropriate and acceptable to specific risk groups, especially in a setting such as Indonesia where sex outside marriage is heavily stigmatised and where sex between males is still illegal and considered a serious offence.[40,41]

While this study clearly showed the feasibility of implementing an SMS intervention to deliver health messages to a cohort of young people in Indonesia, the recruitment locations and the face-to-face recruitment approach limited the total potential reach of the study and resulted in recruiting a more highly educated and lower risk profile than other nationally representative samples.[42,43] The 2017 Indonesian Demographic and Health Survey reported that almost 10% of unmarried women aged 15–24 years with no education have had sexual intercourse, which is higher than those who finished primary and higher education.[43] While among young people aged 16–30 years, the highest proportion of smokers (35.4%) were among those who completed only a primary education; this proportion decreased as

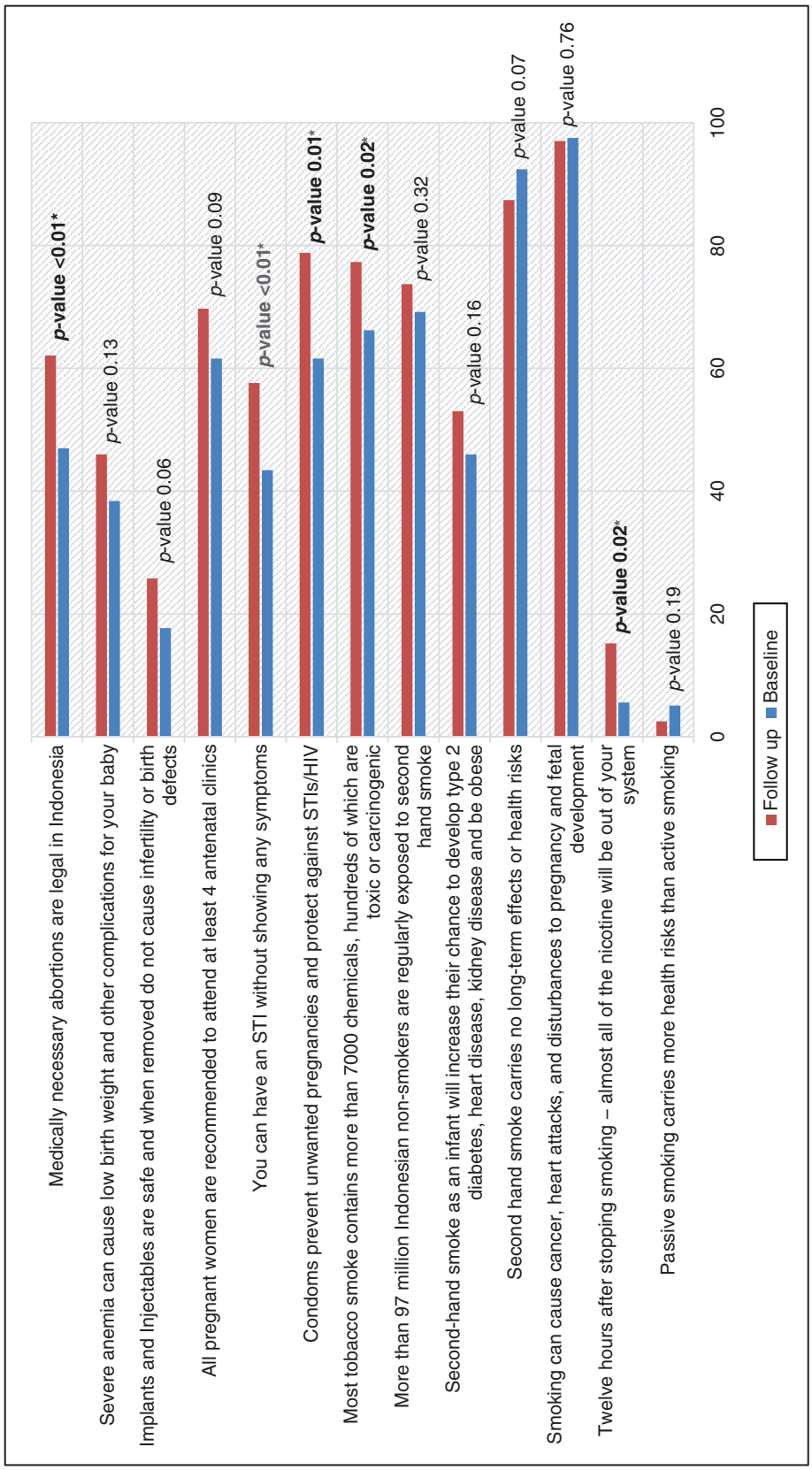

Fig. 2. Proportion of participants correctly answering knowledge questions comparing baseline and follow-up surveys ($n = 198$). *P values are reported for paired McNemar's test of proportions between baseline and follow up.

Table 3. Factors associated with knowledge change among participants who completed both baseline and follow-up surveys (n = 198)
Bold indicates statistical significance. OR, odds ratio; CI, confidence interval; SMS, short message service

	Change in sexual health knowledge							
	Negative/ No change	Positive change	Unadjusted			Adjusted[A]		
			OR	95% CI	*P* value	OR	95% CI	*P* value
Efficacy indicators	*n*	*n*						
SMS dose								
Low dose	55	62	1.0			1.0		
High dose	35	45	1.14	0.6 –2.0	0.6	1.2	0.7 – 2.1	0.6
Learnt something new								
Disagree	8	2	1.0			1.0		
Agree	82	106	**5.2**	**1.1–25.0**	**0.04**	**6.0**	**1.1–32.0**	**0.04**
Found SMS informative								
Disagree	6	3	1.0			1.0		
Agree	84	105	2.5	0.6 –10.3	0.2	2.5	0.6 –10.5	0.2
Found SMS interesting								
Disagree	55	62	1.0			1.0		
Agree	35	45	1.3	0.7 –2.3	0.4	1.4	0.75 – 2.6	0.3
	Change in smoking health knowledge							
	Negative/ No change	Positive change	Unadjusted			Adjusted[A]		
			OR	95% CI	*P* value	OR	95% CI	*P* value
Efficacy indicators	*n*	*n*						
SMS dose								
Low dose	74	43	1.0			1.0		
High dose	44	36	1.4	0.8 – 2.5	0.2	1.36	0.8 – 2.5	0.3
Learnt something new								
Disagree	8	110	1.0			1.0		
Agree	82	77	2.8	0.6 – 13.4	0.2	2.7	0.5 –13.5	0.23
Found SMS informative								
Disagree	6	3	1.0			1.0		
Agree	112	76	1.3	0.3 – 5.6	0.67	1.3	0.3 – 5.8	0.73
Found SMS interesting								
Disagree	34	46	1.0			1.0		
Agree	56	61	0.9	0.5 – 1.6	0.84	0.9	0.5 – 1.7	0.8

[A]Sexual health knowledge models were adjusted for age category, marital status and gender, and smoking knowledge models were adjusted for age category, gender, current smoking status and marital status.

the level of education increased to 15.5% among those in university or graduate level.[42]

Similarly, the Indonesian Family Life Survey reported that smoking cessation between 2007 and 2014 was positively associated with education (aOR: 2.14; 95% CI 1.43, 3.06 for university graduates) and wealth (aOR: 1.60; 95% CI 1.23, 2.09 for the richest group) while, conversely, those with higher education levels and wealth status had lower odds (aOR: 0.81; 95% CI 0.63, 1.02 and aOR: 0.49; 95% CI 0.41, 0.57 respectively) of initiating smoking within the period.[17] Alternative recruitment methods that can reduce selection bias and ensure a more representative sample should be considered for future interventions, including mobile subscription and advertising.[44] As young people continue to increase their use of mobile phones, it is important that health promotion practitioners explore how this technology can be exploited to reach the largest possible audience. Further considerations should be given to which health topics would be most amenable to SMS-style interventions.

Overall, most participants who completed the pre- and post-evaluation surveys found the intervention as acceptable and reported having *learnt something new* or found the text messages *interesting or entertaining and informative*. However, the low completion of the follow-up evaluation survey (42%) limits the generalisability of these results. Among those that did complete the follow-up evaluation survey, only one-third of participants reported receiving the full dose of the intervention, which may reflect low recognition or engagement with the study, potential recall bias or alternatively, low delivery rates of the SMS intervention, although we note only 71 (1%) of the total SMS messages registered as undelivered or bounced. Recall bias may have also had an effect on the limited dose–response relationship reported in this study. To increase engagement with the study, participants suggested making the SMS gateway system a two-way communication channel to facilitate discussion between researchers and participants, and also extending the intervention into an online space such as social media to help increase engagement and provide more detailed information and

links to resources. There is clearly an appetite and potential for SMS and other information communication technologies to be used as a powerful tool to increase knowledge, awareness and health literacy around a range of issues that affect young people.

There were several limitations with this study. While the project was devised as a feasibility and acceptability trial, the limited recruitment across the audience segments limited our ability to conduct any sub-analysis and a lack of a control arm limited our ability to assess the effect. The effect of potential selection bias during screening may have accounted for the under recruitment of married and smoking participants into this study, which subsequently may have affected changes in knowledge, particularly for antenatal care messages that were only received by a smaller proportion of the sample. Face-to-face recruitment was both resource and time intensive and resulted in limited recruitment of young people outside of educational settings. Alternative recruitment methods should be explored to ensure participation of rural populations, ethnic minorities and young women.[45] Of the 235 follow-up participants who completed an evaluation survey, only 198 (84%) were able to be correctly matched to their baseline contacts details. While this is an issue largely for the evaluation and did not necessary have an effect on project implementation, future projects should consider ways to minimise the potential of non-matching. Finally, all data were self-reported and subject to recall and social desirability biases.[46,47]

SMS provides a discrete way to disseminate health information directly to young people, and this was highly acceptable to a relatively urban population in Indonesia. In the rapidly changing environment of new technologies, we must continue exploring new avenues in which to deliver, and evaluate, health promotion to our audiences, and continue to understand how we can best tailor messages through appropriate audience segmentation to ensure maximum effect.

Conflicts of interest

The authors declare no conflicts of interest.

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Appendix 1. SMS Broadcast Schedule to Group A (Unmarried, Male, Smoker)
SMS, short message service; STI, sexually transmissible infection

Week	SMS theme	Sexual health messages	SMS theme	Smoking messages
1	General	Welcome to SMS4Health Study! If you haven't already – complete a short evaluation survey and we will send the 25K rupiah. <survey link>		
2	Reminder	There is still time to complete our short survey for the SMS4Health Study. It takes only 10 min and you will receive an e-credit of 25k rupiah <survey link>		
3	Informative	Did you know that you can have an STI without showing any symptoms?? Get a free test now from Puskesmas – or call Indonesia Planned Parenthood 0274 586767	Factual	Did you know that tobacco smoke contains more than 7000 chemicals, hundreds of which are toxic or carcinogenic? Every cigarette is doing you damage!
4	Informative	There is no cure for HIV–AIDS! The best protection is to prevent getting infected – safe sex is the best way to protect yourself. For more info: guetau.com/	Factual	Let's see the facts! Smoking kills at least 220 000 people each year in Indonesia – quit now and remove yourself from this statistic!
5	Informative	Pill, Suntik, Susuk KB, Implant, Intra Uterine Device (IUD) – are all free and safe contraceptives methods available to you and your partner. Find out how to access them: pkbi-diy.info/	Informative/ Persuasive	One-third of students have tried their first cigarette before the age of 10 years - the earlier you start – the harder it is to quit. Quit before it's too late.
6	Persuasive	Let's talk about sex! Want to know about contraception and ways to reduce that chance of unwanted pregnancy? Find out more – got to www.guetau.com	Persuasive	There is NO such thing as safe tobacco. Kreteks and clove-flavoured cigarettes all carry many of the same health risks as machine manufactured cigarettes. It's an addiction!
7	Persuasive	Got a question about sex or pregnancy but you are too embarrassed to talk about sex or ask questions? It's ok – that's normal. Why not talk to someone who understands - your PIK-KRR peer-educational counsellor!	Factual/ Persuasive	67% of Indonesian males smoke tobacco – this is the highest male smoking rate in the world. This is not something to be proud of – Quit before it's too late.
8	Factual	Medically necessary abortions are legal– if you need help or information, call SAMSARA: Safe Abortion Hotline: 0813 2717 1188; M–F 10 am–6 pm.	Factual/ Persuasive	In 2008, over 165 billion cigarettes were sold in Indonesia – how many did you buy? Save your $$ and quite smoking today!
9	General	Congratulations on participating in the study SMS4Health - complete final evaluation survey and we will send you 25k rupiah. <survey link>		
10	Reminder	If you have not – there is still time to complete the final evaluation survey for the SMS4Health Study. You will receive an e-credit of 25k rupiah <survey link>		