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Application of health action process approach model to promote toothbrushing behavior among Iranian elderly population: a cluster randomized controlled trial

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Abstract

Background Improving the oral health of elderly individuals, involving various healthcare providers, should be a key objective for multidisciplinary teams responsible for their care. We aimed to compare the effectiveness of an oral health education program based on the health action process approach (HAPA) model when provided by a dentist versus a health officer among elderly people.

Methods This cluster-randomized controlled trial included elderly residents aged more than 60 years from 24 municipal neighborhood houses ($n=190$) in Tehran, Iran, in 2021. A questionnaire was administered through face-to-face interviews at baseline to collect sociodemographic characteristics and HAPA model constructs related to toothbrushing behavior. The Simplified Oral Hygiene Index (OHI-S) was also assessed. The neighborhood houses were assigned to two groups via simple randomization: Group A, which received oral and dental health education based on the HAPA model by a dentist and an educational pamphlet ($N=89$); and Group B, which was educated by a health officer and an educational pamphlet ($N=101$). Both groups received reinforcement every two weeks. Follow-up oral examinations were conducted after 1 and 3 months by a blinded, calibrated examiner. The marginal model of generalized estimating equations (GEEs) with Bonferroni post hoc correction was used for intragroup and intergroup comparisons.

Results The frequency of toothbrushing was not significantly different between the two groups ($p=0.09$) after one or three months. However, the frequency of toothbrushing increased significantly in both groups ($p<0.001$). Additionally, no difference was found in the OHI-S score between the two groups ($p=0.56$); nevertheless, there was a statistically significant improvement in oral hygiene status in both intervention groups ($p<0.001$).

Conclusion No difference was observed in the effectiveness of educational interventions using the HAPA model when delivered by a dentist versus a health officer working in a municipal center. Both interventions were effective at promoting the oral hygiene status of elderly individuals. These interventions could be integrated into existing public health programs.

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Trial registration The trial protocol was registered in the Iranian Registry of Clinical Trials (IRCT) on 7-12-2020 (registration number: IRCT20200928048868N1).

Keywords Elderly, Toothbrushing, HAPA model, Oral health, Iran

Background

The older population is increasing substantially [1]. Aging leads to an increased risk of noncommunicable chronic diseases [2, 3] and a gradual decline in physical function [4]. Additionally, an individual's ability to perform adequate oral care may be affected by medical and physical restrictions associated with the aging process [5]. The oral health status of the elderly population is generally deficient, with an elevated prevalence of caries, periodontal disease, and tooth loss [6], which can lead to secondary health problems and impair quality of life and well-being in old age [7–9]. Regular oral care behaviors are highly effective at maintaining healthy oral status in the elderly population [10]. Dental plaque is the primary cause of gingivitis and caries, leading to tooth loss and halitosis [11]. Therefore, plaque removal with a toothbrush is crucial for preventing the deposition of dental plaque [11].

Greater oral health awareness was associated with better oral health care behaviors [12, 13]. Behavior modification approaches such as sociocognitive models of behavior change are based on social cognition, which is a broad term used to describe how individuals encode, process, interpret, remember and then learn from and use information in social interactions with the objective of making sense of the behavior of others and the social environment [14].

The Health Action Process Approach (HAPA) is a theoretical framework designed to better understand health behavior change. The HAPA describes the social-cognitive and self-regulatory processes that are involved in the adoption and maintenance of health behaviors. It is based on the assumption that there is a distinction between a motivational and a volitional phase of behavior and that different psychological constructs are seen as being influential in each of the phases. In the motivational phase, factors such as perceptions of risk, outcome expectancies, and action self-efficacy are proposed to play important roles in motivating individuals into action. In the volition phase, coping self-efficacy, planning, and action control (such as self-monitoring) are proposed as key self-regulatory factors that are important for ensuring that an intended behavior is initiated and then maintained once initiated. Several studies have shown the usefulness of the HAPA for explaining changes in oral health behavior [15–17]. There is also growing support for the effectiveness of HAPA-based interventions in the context of promoting oral hygiene behaviors [16, 18, 19].

Improving the oral health of elderly people by different healthcare providers [20], is one of the key objectives of the multidisciplinary team responsible for their care to increase their quality of life [9, 21, 22]. The integration of oral health promotion into existing health promotion programs should be considered by health authorities to improve geriatric oral health [20]. To the best of the authors' knowledge, no study has been designed based on the principles of the HAPA model for the promotion of oral health in elderly people. Consequently, the present randomized controlled trial is conducted to evaluate the use of the HAPA for promoting toothbrushing behavior and oral hygiene status among the Iranian elderly population. The hypothesis is that the oral health education program provided by a health officer is as effective as the oral health education program provided by a dentist.

The aim of the present study is to compare the effectiveness of an oral health education program based on the HAPA model provided by a dentist and a health officer among elderly individuals in municipality centers in Tehran, Iran.

Method

Trial design

This study was a multicenter, double-blind, parallel, clustered, randomized controlled trial (RCT) with a 1:1 allocation ratio, involving elderly individuals aged 60 years and older residing in Tehran, Iran. The study comprised multiple phases, including a pilot study, baseline assessment, interventions, fortnightly reinforcements for allocated groups, and follow-up examinations after 1 and 3 months. The total study period lasted from February 2021 to October 2021.

The design and planning of this study were based on the Health Action Process Approach Model, with self-reported measures of HAPA constructs and toothbrushing behavior assessed using a valid and reliable researcher-made questionnaire administered at baseline and at 1- and 3-month follow-ups.

The trial protocol was registered in the Iranian Registry of Clinical Trials (IRCT) on 7-12-2020 (registration number: IRCT20200928048868N1).

Study population and randomization

Participants

Eligible participants ($n = 190$) were elderly individuals aged 60 years and older. The inclusion criteria were: Presence of at least 10 teeth in the mouth, residing in selected districts, being a member of the neighborhood health

center, having the ability to communicate with research facilitators, and completing the informed consent form. Individuals with uncontrolled systemic diseases, motor limitation and non-Iranian citizenship were excluded.

Sample size

The sample size calculation is performed with consideration for the study's power and the design effect due to clustering. The sample size is determined as follows: $N \geq 50 + 8$ K [23] where k refer to independent variables. In our study we had two independent variables (time and intervention). So, the minimum sample size was 66.

Due to the intracluster correlation, a design effect is considered during the planning phase to account for the inflation in sample size caused by clustering. The design effect is calculated using the following formula: Design effect = 1+(m-1) ×ρ where (m) is the average cluster size, and ρ is the intracluster correlation coefficient (ICC).

In our study the design effect is = 1+ (132/24–1) ×0.05. So, the design effect is approximately 1.225. This means the effective sample size is inflated by a factor of 1.225 due to clustering. To adjust the sample size for clustering, we multiply the initial sample size by the design effect. Thus, we would need approximately 162 samples to account for clustering effect. Considering 15% loss to follow up, the present study was conducted with a sample size of 190 individuals.

Sampling, randomization, and allocation

Tehran is divided into 22 municipality districts, each containing several municipality neighborhood houses operating within the framework of policies and macrourban management programs. This study was conducted in health centers to achieve better access to the target group, particularly during the COVID-19 pandemic.

A multistage cluster sampling approach was used, with the health centers of selected neighborhood houses as clusters. Six out of the 22 municipality districts were randomly selected, including districts 1 and 5 from the north, 19 and 21 from the south, and 11 and 13 from the center of Tehran. Ultimately, 24 municipality neighborhood houses (four randomly selected from each district) were included in the study. Using the convenience sampling method, 7–10 eligible elderly subjects were selected from each center. Different centers had varying numbers of older people. Consequently, standardizing the number of samples could lead to under-representation in some centers and over-representation in others. The sampling method employed in this study is cluster sampling, conducted using probability proportional to size (PPS) sampling. This approach implies that a greater number of samples were collected from clusters with larger populations.

Following baseline data collection, allocation took place within neighborhood houses as units of randomization. In each selected district, four neighborhood houses were randomized into two equal arms of parallel groups. For simple randomization, each neighborhood house's name was written on a piece of paper and concealed in an envelope. These four neighborhood houses were then randomly allocated into the intervention groups by drawing envelopes randomly. This process was repeated for the six selected districts. Ultimately, 12 neighborhood houses were allocated to intervention Group A ($N = 89$) and 12 to intervention Group B ($N = 101$). A flow chart of the study demonstrating participants at baseline and during two postintervention evaluations is provided in Fig. 1.

Blinding

This trial was double-blind with regard to outcome measure assessment and data analysis. The examiner who conducted the postintervention oral examination was blinded to the group allocation of the study participants. Statistical analysis was carried out by a trial statistician who was blinded to the allocation. The intervention groups were coded without disclosing the labels.

There was no contamination, as participants did not interact with any elderly individuals from the other groups.

Data collection

The data were collected at three time points: baseline (T_0), one-month follow-up (T_1) and three-month follow-up (T_2).

Outcome measurements

Primary outcomes

The primary outcomes for this trial were changes in the self-reported frequency of toothbrushing behavior and constructs of the HAPA model, which were used as sociocognitive factors.

Secondary outcomes

The secondary outcome included improvement in oral hygiene status, measured by a decrease in the Simplified Oral Hygiene Index (OHI-S).

Clinical measure

The OHI-S [24] comprises the Debris Index (DI) and the calculus index (CI). Six teeth in the permanent dentition (buccal surfaces of 3, 8, 14, and 24 and lingual surfaces of 19 and 30) were scored on a scale of 0 to 3. The debris scores were subsequently summed and divided by the number of examined teeth for each individual to calculate the DI. The same process was used to obtain the CI [24]. The sum of the DI and CI was defined as the OHI-S.

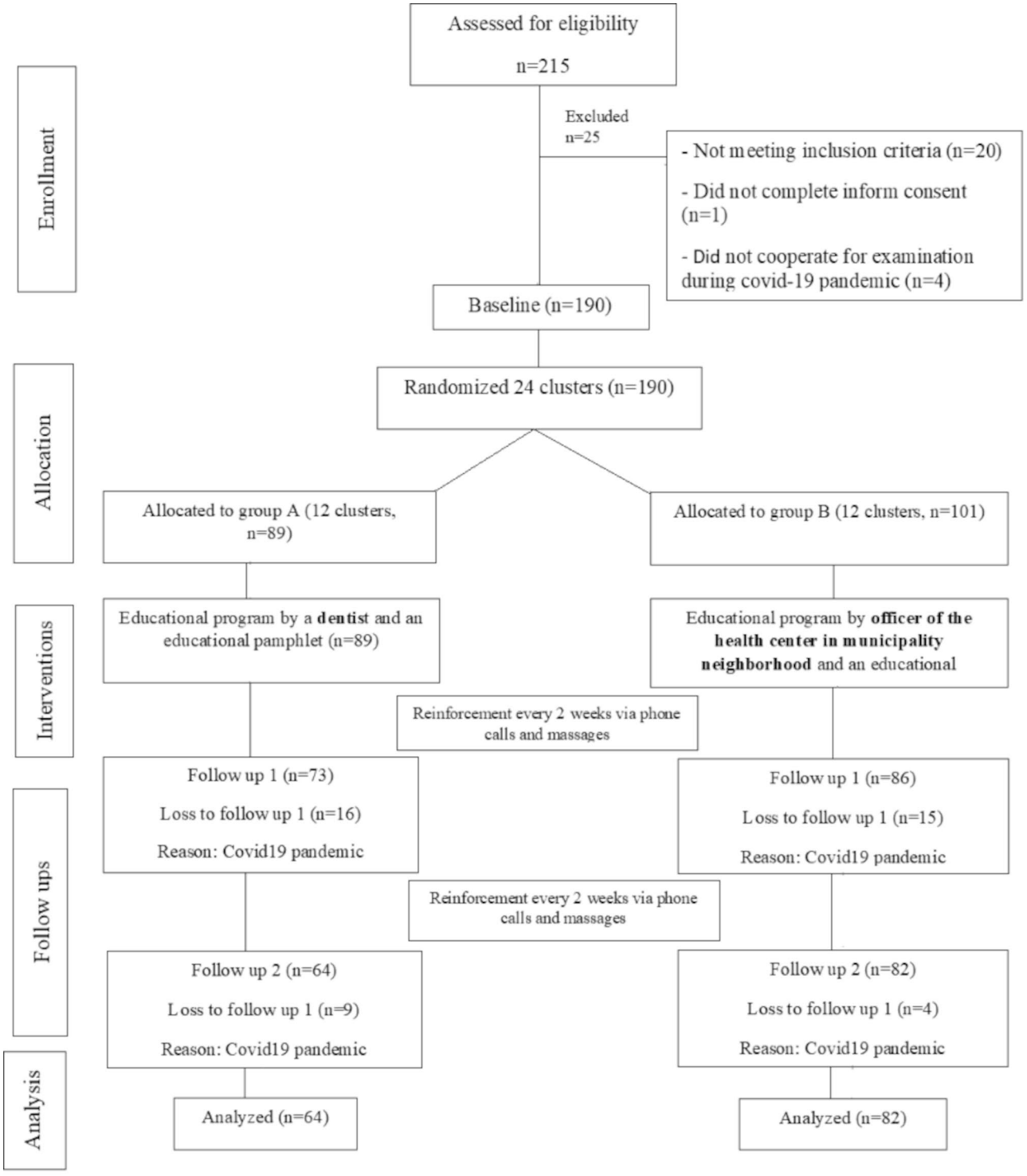

Fig. 1 CONSORT 2010 flow diagram of elderly participants' recruitment and follow-ups

In this study, the OHI-S was considered a quantitative outcome variable.

Self-reported measure

The questionnaire was designed to assess oral health behavior, including toothbrushing, based on the HAPA constructs. The validity and reliability of the questionnaire were assessed before data collection [25].

The HAPA questionnaire included the following constructs and questions. Each construct was measured with a single item (question) for each behavior, and the answers were rated on a 7-point Likert scale from 1 to 7 [25].

To assess the frequency of toothbrushing behavior, participants were asked "How many times do you brush your teeth every day?".

For example, outcome expectancies were assessed by "If I brush my teeth regularly, my breath will be fresh," scored on a 7-point Likert scale ranging from 1 (strongly disagree) to 7 (strongly agree).

Risk perceptions were measured using, for example, "If I do not brush my teeth frequently, the risk of caries will be," scored on a 7-point Likert scale ranging from 1 (very unlikely) to 7 (very likely).

Action self-efficacy was measured by, for example, "I am confident that I can brush my teeth twice a day in the future even if I'm tired," scored on a 7-point Likert scale ranging from 1 (not at all true) to 7 (exactly true).

Behavioral intention toward toothbrushing was measured using, for example, "I plan to brush my teeth twice a day in the coming weeks or months," scored on a 7-point Likert scale ranging from 1 (strongly disagree) to 7 (strongly agree).

Action planning was assessed with "I have made a detailed plan regarding…" followed by (a) "when to brush my teeth," (b) "where to brush my teeth," "how to brush my teeth," (d) "how often to brush my teeth," and (e) "how much time to spend brushing my teeth"; responses were rated on a scale ranging from 1 (strongly disagree) to 7 (strongly agree).

Coping planning was assessed with the following stem item: "I have made a detailed plan regarding…" followed by (a) "what to do if something interferes with my plans," (b) "how to cope with possible setbacks," and "what to do if I forget." The answers were rated on a 7-point Likert scale ranging from 1 (strongly disagree) to 7 (strongly agree).

Maintenance Self-Efficacy: The question was "I'm sure I can brush my teeth twice a day even if it takes a long time to become part of my daily routine." The answers were rated on a 7-point Likert scale from "not at all true" [1] to "definitely true" [7].

Recovery Self-Efficacy: The sample item was "I'm sure I can brush my teeth twice a day again regularly even if I have not done for a month." The answers were rated on a 7-point Likert scale from "not at all true" [1] to "definitely true" [7].

Pilot study and calibrations

To implement the pilot study, a neighborhood house that was not included in the studied clusters was selected, and 30 elderly individuals participated. The two examiners reviewed how to record OHI-S scores (DI and CI) and examined one volunteer health officer from the selected municipality neighborhood to observe the performance of each other and discuss agreement on coding.

For intraexaminer calibration, each examiner examined 10 elderly individuals for OHI-S (DI and CI) assessment. Due to debris removal by an explorer during the first examination, it was not possible to reassess the DI; only the CI was assessed, and the infraclass correlation coefficient (ICC) was calculated (ICC = 0.93).

For interexaminer calibration, 30 elderly individuals were examined by both examiners. For the DI, one of the examiners collected debris by an explorer from each tooth, and both examiners separately recorded the scores. The DI was determined by comparing the scores made by both examiners (ICC for DI = 0.88). For CI, they examined elderly individuals separately (ICC for CI = 0.95). In total, the ICC for the OHI-S was calculated to be 0.89.

In the pilot phase, toothbrushing education according to the constructs of the HAPA model was provided, and a skill checklist was completed for research trainers (dentist and health officer) to confirm the skills of the training they provided in the intervention phase. The results of the pilot study were discussed among the research team members, and minor revisions were made to the study protocol where necessary. A trained dentist was chosen for the control group.

(Group A) to ensure standardization for comparison with the trained health officer (Group B). The validity and reliability of the questionnaire were also assessed before data collection during the pilot study.

Baseline

The questionnaire was completed by the participants as described in the pilot study ($n = 190$). The questionnaire included (1) information on sociodemographic characteristics (age, sex, income, education, employment status, living status, and medical history), (2) information about toothbrushing frequencies, and (3) information about the constructs of HAPA model for toothbrushing behavior.

Oral examinations were performed to assess OHI-S scores. The elderly individuals were examined in municipality neighborhoods in a room, seated in an ordinary chair, under proper illumination from a headlamp, by using a disposable mouth mirror and an explorer, while

taking protective cross-infection control measures involving the use of disposable gloves and masks.

Interventions

The 24 municipality neighborhood houses (clusters) were randomly assigned into two groups:

Group A Elderly participants who received oral health education based on the constructs of the HAPA model by a dentist (control group) and an educational pamphlet.

Group B Participants who received the same educational content from a health officer at the health center in the municipality neighborhood and an educational pamphlet. Both the dentist and the health officer were trained and calibrated by the researchers. The instructions used were the same for both groups.

The educational content included general information on oral health behaviors as well as risk factors, oral hygiene practices, the importance of teeth and their care, the correct way to brush and floss, the importance of controlling the consumption of sugary substances, fluoride use, regular dental visits, and the adverse effects of smoking on oral health. The study also provided explanations for the relationship between general health and quality of life. Information was provided about the positive consequences of daily toothbrushing, and elderly people were encouraged to formulate their own potential pros and cons of regular toothbrushing. Additionally, effective toothbrushing was demonstrated using a dental model. Elders were asked to make concrete plans on when, where and after what activity they would brush their teeth in the future using the if-then formulation. Participants were also asked to identify barriers and possible solutions by making coping plans to increase adherence to their action plans. At the end of the educational session, participants received a pamphlet containing information about oral health and toothbrushing according to the HAPA model.

Reinforcement

Every two weeks both groups received reinforcement after the beginning of the intervention, the instructions were repeated for each participant via phone calls, questions were answered, and problems were addressed. Additionally, WhatsApp messages were sent to reinforce the potential positive outcomes of oral health care. The reinforcement was in different times in two groups, because time of intervention in every center was different.

Statistical analysis

The normality of the quantitative variables was assessed using the Kolmogorov–Smirnov test. Independent t-test was used to compare monthly incomes and mean age between two intervention groups and Chi-square test was used to compare gender, educational status, employment status between two groups. The marginal model of generalized estimating equations (GEE) was used for intragroup and intergroup comparisons. Bonferroni post hoc test was used for pairwise comparisons. The statistical analysis was conducted using SPSS version 25. A p value less than 0.05 was considered to indicate statistical significance.

Ethics statement

This study was approved by the Research Ethics Committee of Tehran University of Medical Sciences (IR.TUMS.DENTISTRY.REC.1399.102). Before completing the questionnaires and oral examinations, the researcher explained the study purpose and obtained written or verbal informed consent from the elderly individuals for voluntary participation. All the information collected from the respondents during this research was kept confidential. All identifiable details of the participants will be separated from the coded details. The identifiable details and data entered on the computer will be password protected and accessible only to the researchers.

Results

Sociodemographic characteristics

The mean ages of participants in groups A and B were 63.90 ± 3.78 and 63.71 ± 4.19, respectively. In both groups, there were fewer males than females. The baseline sociodemographic characteristics of the participants, including age, sex, income, educational status, and employment status, are presented in Table 1. The sociodemographic variables did not show differences between the two intervention groups.

The sociodemographic characteristics of the dropped-out persons are the same as those present in the study. No statistically significant difference was observed regarding age, gender, monthly income, educational status and employment status (p-value > 0.05).

HAPA model constructs

According to the GEE models for the HAPA constructs, the interaction between group and time effects was not statistically significant. Consequently, the results were shown in models fitted only with the group and time variables as fixed effects. The GEE model fit showed that HAPA model constructs, including risk perception, outcome expectancies, action self-efficacy, intention, action planning, coping planning, maintenance self-efficacy, and recovery self-efficacy, did not significantly differ between the two groups. However, the time effect was statistically significant in both groups ($P < 0.05$) (Table 2).

Table 1 Socio-demographics characteristics of study subjects in two groups at the baseline

Variable	Group A ($n=89$) *N* (%)	Group B ($n=101$) *N* (%)	*p*-value
Age (mean ± SD)	63.9 ± 3.78	63.71 ± 4.19	0.31**
Gender			0.15*
Male	14 (15.7)	9 (8.9)	
Female	75 (84.3)	92 (91.1)	
Educational status			0.96*
Illiterate	4 (4.5)	10 (9.9)	
Reading/writing/primary school	26 (29.2)	23 (22.8)	
Middle school/Diploma	33 (37.1)	51 (50.5)	
Associate/Bachelor degree	21 (23.6)	13 (12.9)	
Master/PhD Degree and above	5 (5.6)	4 (4)	
Employment status			0.46*
Unemployed	2 (2.2)	1 (1)	
Retired	24 (27)	20 (19.8)	
Employed	16 (18)	16 (15.8)	
Housewife	47 (52.8)	64 (63.4)	
Monthly Income ($)			0.06**
Below 165	25 (28.1)	24 (23.8)	
166–332	25 (28.1)	41 (40.6)	
333–499	24 (27)	32 (31.7)	
500–749	9 (10.1)	3 (3)	
750 or more	6 (6.7)	1 (1)	

**: Independent t-test was used to compare monthly incomes and mean age between two groups

*: Chi-square test was used to compare gender, educational status, employment status between two groups

For all constructs, pairwise comparisons were conducted between three time points: baseline to one-month follow-up (T_0-T_1), baseline to three-month follow-up (T_0-T_2), and between the two follow-ups (T_1-T_2). The results showed that all the changes in the HAPA model constructs were statistically significant between baseline and the second follow-up (T_0-T_2) and between the first and second follow-ups (T_1-T_2) in both Groups A and B ($p<0.001$), with the exception of outcome expectancies.

Toothbrushing behavior and OHIS

Between-group comparisons of the frequency of toothbrushing are presented in Table 3. No statistically significant differences were observed between Groups A and B at baseline or at the one-month or three-month follow-up. However, the frequency of toothbrushing increased after the interventions in both groups.

Table 4 displays the GEE model fitting results, which show that the frequency of toothbrushing did not significantly differ between the two groups ($p=0.09$), while the time effect was statistically significant in both groups ($P<0.001$).

The GEE model also demonstrated that the OHIS did not significantly differ between the two groups ($p=0.56$), but the time effect was statistically significant in both groups ($P<0.001$); that is, the intervention was effective in both groups ($p<0.001$).

The mean differences in the Simplified Oral Hygiene Index indicated that the intervention in both groups effectively reduced the OHIS during T_1 and T_2 compared to baseline (T_0). However, there were no significant differences between Groups A and B in this regard (Fig. 2).

Discussion

The present randomized controlled trial aimed to compare the effectiveness of an oral health education program based on the HAPA model provided by a dentist and by a health officer among elderly individuals in municipality health centers in Tehran, Iran.

According to the study results on toothbrushing behavior, there were obvious increases in the T_1 and T_2 time intervals compared with the T_0 interval in both groups. However, our findings did not reveal any differences between the two intervention groups. This finding showed that the frequency of toothbrushing behavior effectively increased at the one-month and three-month follow-ups after both interventions in elderly individuals. Additionally, the oral hygiene status of the participants in both groups improved. Weizi and colleagues showed that the HAPA theory-based mini-program significantly improved oral health behavior and oral hygiene outcomes in young adults treated with fixed orthodontic appliances over the 12 weeks of the study [26]. Moreover, in a cluster randomized controlled trial study, Scheerman et al. demonstrated that oral health intervention resulted in significant improvements in toothbrushing behavior and clinical oral health indicators (CPI and VPI) as well as more positive social cognitions based on the HAPA

Table 2 Evaluation of interventions on HAPA model constructs using GEE model

Variable		Statistic (*P*-value)	Pairwise Comparison
Outcome Expectancies	Group	1.507 (0.220)	-
	Time	8.641 (0.013)	T_0 vs. T_1: 0.711 T_0 vs. T2:0.029 T_1 vs. T_2: 0.043
Risk Perception	Group	1.011(0.315)	-
	Time	46.843(< 0.001*)	T_0 vs. T_1: 0.048 T_0 vs. T_2 < 0.001 T_1 vs. T_2 < 0.001
Action Self-Efficacy	Group	1.270 (0.260)	-
	Time	29.600 (< 0.001)	T_0 vs. T1: 0.187 T_0 vs. T_2 < 0.001 T_1 vs. T2 < 0.001
Intention	Group	0.403 (0.525)	-
	Time	36.656(< 0.001)	T_0 vs. T_1: 0.01 T_0 vs. T_2 < 0.001 T_1 vs. T2 < 0.001
Action Planning	Group	0.050 (0.824)	-
	Time	62.332 (< 0.001)	T_0 vs. T_1: 0.001 T_0 vs. T_2 < 0.001 T_1 vs. T_2 < 0.001
Coping Planning	Group	0.111 (0.740)	-
	Time	50.762 (< 0.001)	T_0 vs. T1: 0.001 T_0 vs. T2 < 0.001 T_1 vs. T2 < 0.001
Maintenance Self-Efficacy	Group	0.098 (0.755)	-
	Time	36.241 (< 0.001)	T_0 vs. T_1: 0.587 T_0 vs. T_2 < 0.001 T_1 vs. T_2 < 0.001
Recovery Self-Efficacy	Group	2.040 (0.153)	-
	Time	33.622 (< 0.001)	T_0 vs. T_1: 0.324 T_0 vs. T2: 0.001* T_1 vs. T_2 < 0.001

T_0: Baseline, T_1: One month follow up, T_2: Three months follow up from baseline

*The mean difference is significant at the 0.05 level.

Table 3 Between groups comparisons of frequency of tooth-brushing among study participants (*N* = 190)

Time	Group		*p*-value
	A (*n* = 89)	B (*n* = 101)	
	Mean ± SD	Mean ± SD	
Base Line (T_0)	4.75 ± 1.25	5.05 ± 1.08	-1.716 (0.08)*
Follow Up1 (T_1)	4.93 ± 1.04	5.15 ± 0.94	-1.268 (0.20)
Follow Up3 (T_2)	5.05 ± 0.95	5.26 ± 0.91	-1.44 (0.15)

T_0: Baseline, T_1: One month follow up, T_2: Three months follow up from baseline

*The mean difference is significant at the 0.05 level, t-test was done

model and OHRQoL among Iranian adolescent students in the short and long term [27].

The improvements observed in the present study may be partly due to the reminder messages in WhatsApp, which were sent to both groups, as well as phone call reminders every two weeks. A systematic review showed that SMS reminders make better prospective memory and reinforce behavior change interventions by reminding recipients to involve with behaviors they wish to change [28].

Table 4 The results of GEE analysis of tooth-brushing behavior and OHIS after intervention and follow ups in study participants (*N* = 146)

Variable		Statistic (*P*-value)	Pairwise Comparison
OHIS	Group	0.33 (0.56)	-
	Time	29.85 (< 0.001*)	T_0 vs. T_1 < 0.001* T_0 vs. T_2 < 0.001* T_1 vs. T_2: 0.02*
Tooth-brushing	Group	2.75 (0.09)	-
	Time	17.23 (< 0.001)	T_0 vs. T_1 < 0.01* T_0 vs. T_2 < 0.001* T_1 vs. T_2: 0.003*

T_0: Baseline, T_1: One month follow up and T_3: Three months follow up

*The mean difference is significant at the 0.05 level

The present findings showed that changes in the hypothetical determinants of action (HAPA constructs) lead to changes in the relevant behavior (increase toothbrushing frequencies) and, as a consequence, oral hygiene status. Our study results also support the idea that it is necessary to target self-regulatory processes, such as those specified in the HAPA model, in addition to motivational variables [29].

The present study also indicated that the interventions were significantly effective on the HAPA constructs, which included risk perception, outcome expectancies, action self-efficacy, intention, action planning, coping planning, maintenance self-efficacy and recovery self-efficacy, in both groups. All the HAPA model constructs were enhanced at T_1 and T_2 compared with T_0 in groups A and B. The psychological determinants of oral health behavior and oral health outcomes have also been indicated in many contexts [25, 30, 31]. A recent systematic review and meta-analysis showed that intention, self-efficacy, social influence, and coping planning are important psychosocial factors of toothbrushing [31].

In the majority of the studies, using the HAPA model, the targeted intervention involved flossing; the population consisted of students, adolescents and dental patients; and all the studies used only a selection of the HAPA constructs [32]. The present research employed a cluster randomized trial methodology and was the first to apply HAPA, which targets toothbrushing behavior in elderly individuals. The application of the HAPA, a model recognized for its effectiveness in behavioral change, could afford more reliable estimations. Blinding regarding the outcome measure assessment and data analysis could reduce the risk of bias. The interventions were provided by trained health officers who had stable workforces in municipality centers, facilitating the integration of oral health promotion into existing health programs. In addition, the reminder messages sent via WhatsApp and by phone calls for both groups may have a supportive

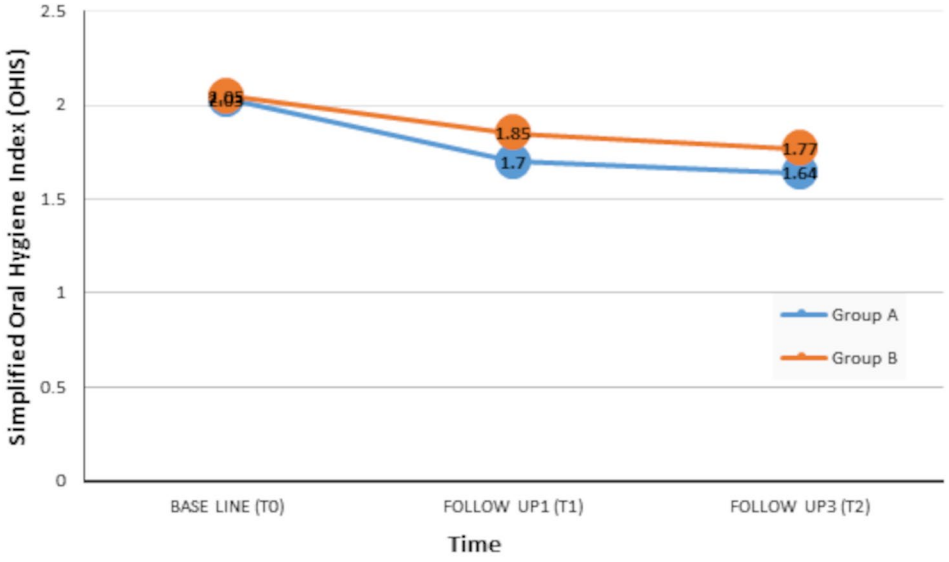

Fig. 2 The mean differences of Simplified Oral Hygiene Index (OHI-S) at T0, T1 and T2 in two groups

role in promoting the consistency of the training and behavior enhancement.

Unfortunately, because of the onset of the COVID-19 pandemic, some of the baseline samples were lost to follow-up due to biological risk. Additionally, it was difficult to compare the results with those of previous studies because they were conducted in different age groups and targeted different behaviors. Most of the study participants were women. This finding was in accordance with the pattern of attendance at health centers, especially during working hours. Men are more likely to have a job after official retirement and are busy working during the day. However, this topic should be considered in future studies. It is recommended that similar studies with larger sample sizes and longer follow-up durations be designed.

Conclusion

In the present study, no difference was observed regarding the effectiveness of educational methods using the HAPA model by dentist as the gold standard versus a health officer at the municipality center on the oral hygiene status of elderly individuals. The results indicated that trained health officers at municipality centers can act as available and appropriate workers in oral health promotion programs to improve oral hygiene skills and enhance the self-efficacy of elderly people in oral health behaviors.

Abbreviations

HAPA	Health Action Process Approach
OHI-S	Oral Hygiene Index Simplified
DI	Debris Index
CI	Calculus Index
GEE	Generalized Estimating Equations

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Author contributions

F.M, K.S, M.G, and AR.S. contributed to the study's conception and design. Data collection was performed by F.M. Supervision was done by K.S and M.G. Data analysis was performed by F.M, J.J and AR.S. The first draft of the manuscript was written by F.M. All authors commented on previous versions of the manuscript. All authors read and approved the final manuscript.

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Data availability

The datasets used and analyzed during the current study are available from the corresponding author upon reasonable request.

Declarations

Ethics approval

Ethical clearance sought from Ethics Committee, Tehran University of Medical Sciences (IR.TUMS.DENTISTRY.REC.1399.102).

Consent to participate

The research was conducted in accordance with the principles and guidelines of the Declaration of Helsinki. Written/ verbal informed consent was obtained from all participants before their involvement in the study. Subjects were assured that they could withdraw from the study at any time and that their personal information would be kept confidential.

Consent for publication

Not applicable.

Competing interests
The authors declare no competing interests.

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