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A new complementary approach for oral health and diabetes management: health coaching

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Background: Health coaching (HC) is based on 'partnering with clients in a thought-provoking and creative process that inspires them to maximise their personal and professional potential' to adopt healthy lifestyles through 'building awareness and empowerment'. This study's objective is to assess, for the first time to our knowledge, the effectiveness of HC compared with health education (HE) using clinical and subjective measures among type 2 diabetes (DM2) patients in Turkey and Denmark. **Methods:** This stratified random prospective study selected type 2 diabetes patients in Turkey (n = 186) (TR) (2010–2012) and in Denmark (n = 116) (DK) (2012–2014). Participants were assigned to HC or HE groups. Selected outcomes were HbA1c, periodontal treatment need index (CPI), health behaviours and anthropometric measures. The study duration was 12 months (6 months initiation-maintenance, 6 months follow-up). **Results:** At baseline, there were no statistically significant differences between the HC and HE groups. Post-intervention, a reduction of HbA1c in the HC groups was observed (TR: 0.8%; DK: 0.4%, $P < 0.01$) but not in the HE groups. The HC patients had a higher reduction in CPI than the HE group ($P < 0.01$). Principal component analysis showed that HbA1c, CPI and 'behaviour change' compose one cluster in the HCTR and HETR groups. Three clusters were formed for the HCDK; respectively HbA1c and CPI, lean mass and body fat percentage, 'behaviour change'. **Conclusions:** The results indicate that HC has a greater impact on DM management and health outcomes. There is a need for common health promotion strategies with behavioural interventions such as health coaching for the management of type 2 diabetes that focus on multidisciplinary approaches including oral health.

Key words: *Health coaching, oral health, HbA1C, health education, diabetes type 2*

INTRODUCTION

Globally nearly 400 million people have diabetes and that prevalence will be 600 million by 2035[1]. Moreover 90% of adults living with diabetes have diabetes type 2 (DM2)[2], associated with more unhealthy lifestyles. Diabetes is expected to be the 7th leading cause of death in 2030[2].

A recent meta-analysis showed that periodontal diseases (PDs) may influence poor metabolic control and its complications[3]. This work amongst others suggests that there is bidirectional association between DM2 and PD; DM2 increases the risk for and severity of PD[4], individuals that have been diagnosed with PD are more likely to have DM2 and/or poor glycaemic control[5–7]. Additionally longitudinal observational studies report that severe periodontitis has a significant adverse effect on risk for poor glycaemic control[8,9]. DM2 and PDs share common pathophysiological mechanisms[10–12] that are influenced by lifestyle behaviours such as poor diet, tobacco use and lack of exercise[13,14]. International health organisations such as the WHO and International Diabetes Federation emphasise that oral health promotion focusing on behavioural interventions should be integrated in diabetes management programmes. However, the integration of oral health information with health behaviour interventions has been slow to develop.

Self-management seems to be the cornerstone to improving health outcomes for those living with DM2 and PDs[15]. However, the evidence suggests that many people with DM2 find it problematic to maintain a healthy lifestyle, despite putting themselves at greater risk of disease sequelae associated with DM2 and PD[15,16]. While tailored behavioural interventions are known to have a significant and positive effect upon people's health behaviour[17], exploration and activation of patient-internal resources are keys to

adherence to healthy lifestyles and successful management of systemic diseases such as DM2[18]. Training people to strengthen emotional and cognitive capabilities is known to improve health learning capacity[19]. Therefore, there is a need to use an intervention for patients with DM2 which is tailored to their psychosocial characteristics and permits the self-identification of personal resources to enable them to adopt positive self-care practices. One such approach is health coaching (HC)[20]. Health coaching, in this regard, is a new concept for medical practices and includes such practices as collaboration with clients to support a thought inspiring self-exploratory journey that facilitates self-management[20,21].

The objective of the current study was to assess the effectiveness of HC compared with a health education (HE) intervention on the management of glycaemic control and periodontal health, by the use of clinical and subjective outcomes among DM2 patients in Turkey and Denmark.

METHODS

This project's first phase was finalised in Turkey in 2012 and then the second phase in Denmark between 2012 and 2014. The study includes DM2 adults between the age of 39 and 79, living in Istanbul, Turkey (n = 186), visiting a medical clinic for regular DM2 healthcare, and adults living in Denmark (n = 116), visiting dental clinics of the University of Copenhagen, Denmark (*Figure 1*).

The eligibility criteria for all participants were: (i) having a clinical diagnosis of DM2, (ii) aged 30–70, (iii) having at least four functional teeth. Patients with severe somatic/mental illness, who were hospitalised, with severe kidney or cardiovascular disease or incurable cancer, were excluded. Those living outside Istanbul or Copenhagen were excluded.

The study has been conducted in full accordance with the World Medical Association Declaration of Helsinki. The Ministry of Health (Turkey) and Regional Ethical Committee (Copenhagen, Denmark) granted the ethical approval and written permission to conduct the study.

The outpatient clinics of two hospitals (Istanbul, Turkey) were used to randomly select the participants with DM2. Sample size calculation and methodology were explained in detail in earlier publications[22–24]. Danish participants were recruited from the electronic health records of the School of Dentistry in May 2012. This research was approved by the Internal Review Board of University of Copenhagen. The sample size calculation was built on the expected difference between the pre- and post-coaching HbA1c level (glycated haemoglobin, measured primarily to identify the 3-month average plasma glucose concentration), according to our previous study in Turkey[22,23]. With a power of 0.9, $\alpha = 0.05$ and an expected difference in HbA1c of 0.67% after 6 months, with a SD = 1.2 and a 95% confidence interval, the number of participants was calculated as 72 (paired t-test). With an expected drop-out rate of a maximum of 25%, in

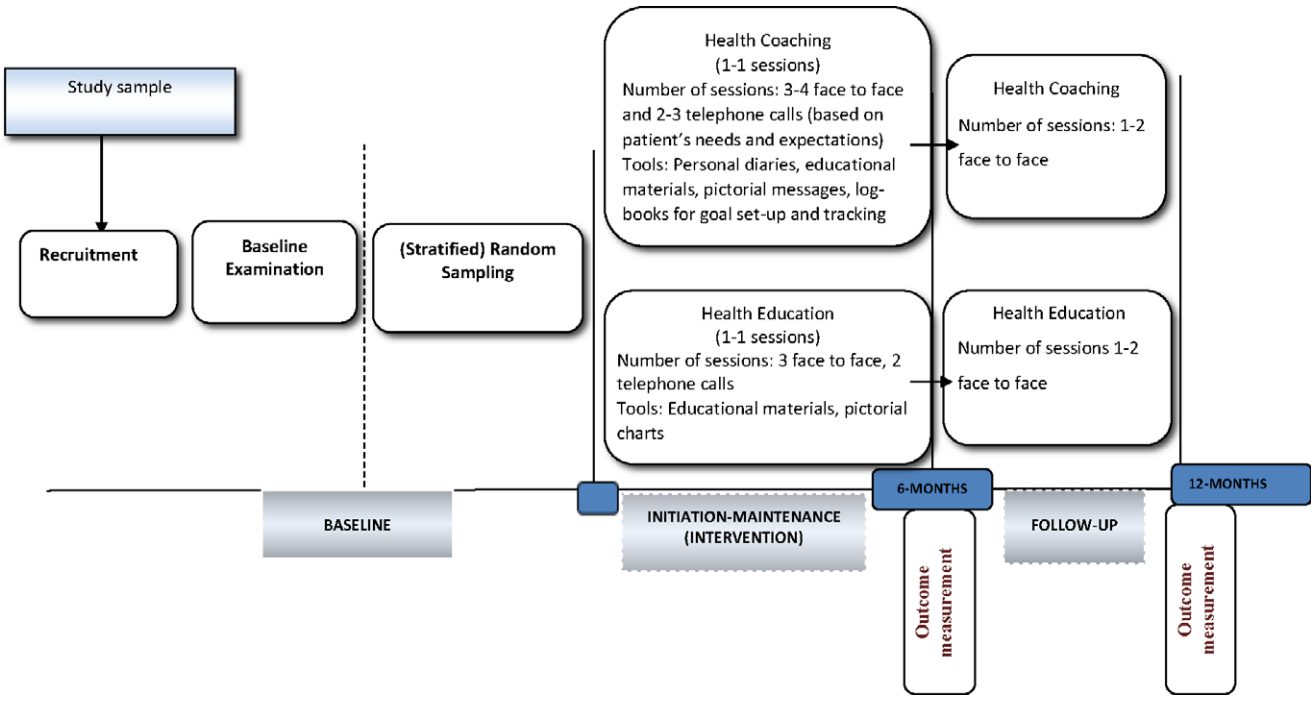

Figure 1. Study design

total 116 participants were recruited. G*power was used to calculate the power and sample size [effect size, w00.5–0.7, α err prob. 00.05, power (1 − β err prob.) 0.95][25].

One researcher was hired for the pre-selection process so that the remaining researchers were blind to the selection process. Eligible patients, based on the screening, received an informative letter about the study, and a pre-paid return envelope including an expression of interest form. Patients not returning the form within 2 weeks were called to ask about their willingness/interest to participate in the study. Those returning the forms were invited to the clinics and they were asked to bring their signed informed consent form, self-assessed questionnaires and the latest medical records (HbA1c, LDL, HDL, fasting blood glucose) from the hospital registries. The data were anonymised and de-identified prior to analysis.

For the selection of Danish participants stratified random sampling was used to prevent an imbalance between the HC and HE groups for gender and ethnicity which could influence the prognosis or intervention responsiveness, in agreement with Cavender *et al.*[26], and literature reviews[27,28]. The present study was based on the fully informed consent of the patients, according to the Copenhagen Regional Ethical Committee rules; all participants were fully informed about the intervention groups including their contents. Most of the participants consented to their randomly allocated study groups (HC/HE). However, 43 male patients (23 non-Danish and 20 Danish) strongly preferred to be in the HE group, stating certain barriers to participating in the HC group (work schedule, time, will, no need, etc.). Therefore, a partially randomised patient preference trial (PRPP) design was used, in line with the study of Cooper *et al.*[29] and Henshaw *et al.*[30]. As discussed in our earlier study[24], this kind of experimental design is preferred when the blinding of the interventions is difficult or impossible and some of the potential participants prefer one or other of the interventions[28,31]. King *et al.*[32] suggested in their systematic literature review, when participants declare strong preferences against one particular intervention arm in randomised controlled trials, the PRPP design could be used to prevent any bias by reducing or removing a preference/motivation effect when evaluating motivation-based studies. In the present study, after the participants were randomised by gender and ethnicity, females were randomly allocated to the HC and the HE groups. Therefore the coaching group was a randomised group, whereas the education group was partially randomised patient preference design group composed of males with strong preference for HE and females with no strong preference for either HE or HC.

Of 186 Turkish and 116 Danish invited participants, respectively, 96% ($n = 179$) and 94% ($n = 109$) consented to participate in the study. At the baseline, the attendance rate at the clinical oral examinations was 100% and 90%, respectively, among the Turkish ($n = 179$) and Danish patients ($n = 98$). At post-intervention, 178 Turkish and 104 Danish participants continued the study by returning questionnaires and/or attending clinical examinations. The attendance at the final oral examinations was 178 for the Turkish participants and 98 for the Danish. From baseline to post-intervention, the dropout rates were 1 and 5, respectively for the Turkish and Danish study groups.

Intervention

The two stages of the study (6-months initiation-maintenance phase, then 6 months follow-up), described in detail earlier[22–24], were as follows:

Initiation-maintenance phase

Health Coaching (HC Intervention): The HC approach (*Table 1*) in the present study is a dynamic and collaborative process between the coach and the patient to maintain and adopt healthy-lifestyles supported by empowerment of capacity building skills (self-efficacy, diabetes coping skills)[20–24]. The HC sessions, conducted by a professional health coach (AB Cinar) in both countries, focused on motivating and supporting the patients for maintenance and improvement of lifestyles with the aim of at least a 0.4–0.8% reduction in HbA1c ($P < 0.05$) in line with the earlier studies[15,33].

The HC approach in the present study originally stems from the internationally accredited coaching framework (International Coaching Community). It uses a blend of specific psychological techniques and some theories including motivational interviewing[34], neurolinguistic programming[35] and self-efficacy theory[36].

Patients in the HC group received 3–4 face-to-face sessions and 2–3 telephone calls. The timeframe for face-to-face HC sessions ranged between 20 and 60 minutes, according to the patient's needs, challenges and progress.

Educational materials (a physical exercise DVD and chi-balls, cookery books for DM2 patients, oral hygiene brochures based on patient motivation principles) were distributed to support the adoption of new positive health behaviours. Personal log-books to screen improvement in achieving personal health goals along with colourful activity charts were given to each patient. At every session, the patients were provided with written feedback on progress. Pictorial messages

Table 1 Comparison of health coaching approach with health education model

Health coaching approach	Health education model
Focuses on	
• Positive health maintenance/improvement	• Disease/problem (disease oriented)
• Client's whole life and well-being	• Condition-specific factual information about the specific health condition or health behaviour
• Self-identified health goals and action plans	
The agenda is given	
• The client and not by the coach: Client is the expert for his/her own health	• The medical professional: Health professional/ educator is the expert for client's health
Theme	
• Flexible and the theme can be modified by the coach by using specific framework such as open questions, summaries and reflections	• Mostly standardised for all clients suffering from a specific disease, decided by the health care professional
Motivation and goals	
• Intrinsic motivation	• Extrinsic motivation
• Addresses internal resources	• Goals/targets are presented by the health professional
• Facilitates client engagement and activation towards the self-identified health goals	• Standardised pre-described regimes to improve health for all clients
• Coaches elicit ideas and resourcefulness from clients, encouraging them to improve their health by enabling them to see that life from today to future is a personal project that they can build up by exploring and using their own resources	
Communication pathways and concepts	
• Asked	• Told
• Guided	• Informed
• Challenging, determined, ambitious	• Good client *vs.* non-compliant
• Doing with, listening	• Doing to
• Proactive; focusing on improve positive health from today to the future	• Reactive: focusing on how to treat disease/ problem
• Client centred	• Clinician centred
• Informed choice	• Options presented

and coaching games were used to prevent any possible attrition.

Health Education (HE) Intervention: Health education sessions (*Table* 4) were conducted by a dental health professional. Participants in the HE group received standard lifestyle advice after baseline examination and were invited for two more face-to-face and 1–2 telephone sessions during the initiation-maintenance period. The timeframe for face-to-face HE sessions ranged between 20 and 60 minutes, according to the patient's needs, challenges and progress. The lifestyle advice included the oral hygiene and diabetes management (blood-glucose monitoring, dietary regimes, regular physical exercise, non-smoking, twice daily tooth-brushing). In addition, HE sessions were on the phone for 5–8 minutes. Telephone advice was supported by the educational brochures. The HE sessions were explained in detail earlier[22–24].

A 'thank you' letter and a brief summary following each assessment were provided to all participants in the HE group in order to minimise attrition over the 12 month study duration.

The participants also received standard, diabetes self-management- and oral health-related education brochures during baseline, 6- and 12-months.

Follow-up phase

The HC and HE group participants received 1–2 face-to-face sessions to closely screen the maintenance and improvement of their transformation for positive lifestyles.

Motivational Incentives for all Participants: Oral health promotion tools such as toothbrushes and toothpastes as motivational incentives were given to all patients during both initiation-maintenance and follow-up phases. Dental scaling (cleanings) were provided at no cost to the participants during initiation-maintenance phase, and certificates of attendance at the cessation of the study were used as other motivational tools. Periodontal cleaning was standard for

every participant; thus did not vary according to baseline examination.

Outcome variables

Clinical variables

The present data were taken from the routinely collected data [clinical measures and the medical records at baseline and after follow-up (12 months from baseline)]. The latest medical records at the hospitals were used to gather data on HbA1c. For further analysis, participants with HbA1c ≥8% was recorded as poor glycaemic control and those with HbA1c <8% as good glycaemic control, based on the International Diabetes Federation guidelines[23,37].

Participants were invited for a periodontal clinical examination [Community Periodontal Need Index (CPI)] and a record of anthropometric measures.

Two calibrated clinicians in Turkey (intraclass and interclass κ value was 0.80 on average, as explained earlier[22]) and one dental hygienist in Denmark[22,24], performed the periodontal examinations. The CPI was used to monitor the alterations of the periodontal treatment needs over the intervention period. WHO guidelines were followed for the measurement[38,39]: the index teeth in six sextants[11,16,17,26,30,35,36,40–42] were probed and the highest score for each sextant was recorded. If no index teeth/tooth were present in a sextant qualifying for examination, at least two non-index remaining teeth in that sextant were examined and the highest score was recorded. Categorisation for CPI was as follows: CPI = 0: 'healthy gums', CPI = 1: 'gingival bleeding on probing but no calculus'; or CPI = 2: 'calculus and bleeding', CPI = 3: 'shallow periodontal pockets (4–5 mm)', CPI = 4: 'deep periodontal pockets (6 mm or more)', exactly as described by WHO guidelines[38,39]. For further analysis the mean of the maximum score was taken.

Anthropometric measures: Tanita TBF-300-A which utilises foot-to-foot bio-electrical impedance analysis to measure the body composition, was used for on-site measurement of body mass index (BMI) and fat mass percentage% (BFP). Lean mass was calculated by subtracting weight from fat mass.

Behavioural variables

Self-reported toothbrushing frequency (TBF) and physical activity were taken from our earlier study[43]. *TBF* was determined as follows: 'How often do you brush teeth?' TBF recorded on a 5-point Likert scale ('never = 0, once a week or less = 1, 2–5 times/week = 2, once daily = 3, twice or more daily = 4'), was re-classified into 'once a day or less' and 'at least two times a day'.

Self-reported physical activity (PA) was determined by the question 'Please select the activity that fits you best'[43]. There were four options: '(i) read, watch TV or other things in a sitting position; (ii) walking, active house work at least four hours per week; (iii) jogging, running and other kind of running exercises or working hard in a garden 2–3 hours per week; (iv) tough training, competition sport more than once a week.' For further analysis, dichotomisation was used: the last three categories were categorised as 'physically active' because the responses to the last two categories were low.

Behavioural change referring to a change in physical activity and toothbrushing frequency from baseline to post-intervention was coded by four categories:

Code 1: One behaviour reported – negative or no change

Code 2: Both behaviours reported – negative or no change in both

Code 3: Either one behaviour reported-positive change – or both behaviours reported – one with positive change

Code 4: Both behaviours reported – positive change in both

Those who reported 2–3 times daily tooth-brushing both at baseline and post-intervention were coded as either 3 or 4 depending on the change in physical activity. As code 1 was reported only at 5%, the 'behavioural change' variable was dichotomised as code 1 = negative or no change (including code 1 and 2), and code 2 = positive change at least at one behaviour (referring to code 3 and 4).

Data analysis

SPSS (V 17 Chicago Illinois) was used for statistical analyses. The Spearman rank correlation and independent sample *t*-test were used, respectively, to assess the correlation and baseline similarities/differences between the HC and HE groups. Paired-sample *t*-tests were utilised for normally distributed data to analyse the change over time for each group alone.

Factor analysis can be used to hypothesise an underlying construct by the principal component analysis (PCA) approach. The PCA approach is used to find several combinations of variables that are called components/clusters, which adequately explain the overall observed variation, thereby reducing the complexity of the data, as described earlier[43]. Factor analysis, in the present study, was applied to the variables by use of PCA and Varimax rotation to analyse, not the associations, but the interrelationships between HbA1c, CPI, behaviour change and anthropometric measures, thereby showing that these variables share common background factors and underlying dimensions. These variables were allocated to discriminative clusters based on factorial loadings, ranging from the

highest to lowest values. The loadings equal to or below 0.30 were extracted for ease of communication. The clusters were named according to the variable with the highest loading. Factors were extracted according to meeting the Kaiser criterion of eigenvalue greater than 1. This analysis was used in our earlier studies[24,43] and also extensively in the literature to analyse the interrelationships and common underlying dimensions of health and related behaviours[44–46].

As the Danish coaching and education groups were disproportionately represented, the sampling weighting technique was used to represent the groups equally, in line with the earlier studies and literature[41,47]. The proportion of 'total sample size: education/coaching sample size' was calculated and 2:3 weighting for the 'education: coaching' groups were used. The sampling weighting is commonly used when the stratified random sampling is used[41,47]. For all tests, the statistical significance was set at 0.05.

RESULTS

Baseline

There was no statistical difference between the HC and HE groups in both Turkish and Danish study groups regarding the socio-economic background and clinical parameters (*Table 2*). The majority of the Turkish HC and HE participants reported good control of HbA1c (70% *vs.* 63%, $P \geq 0.05$). It was similar for the Danish groups (HC: 75% *vs.* HE: 80%, $P \geq 0.05$).

Turkish results

The majority of the Turkish participants reported poor tooth-brushing habits (less than twice daily: HC: 68%, HE: 78%), ($P \geq 0.05$). Both the HC and HE groups were physically inactive to a moderate extent (HC: 41% *vs.* HE: 44%, $P \geq 0.05$).

Danish results

Among the Danish participants, the percentage of poor tooth-brushing habits were low (HC: 35%, HE: 33%, $P \geq 0.05$). Both the HC and HE groups reported moderate levels of physical activity (43% *vs.* 47%, $P \geq 0.05$).

Post-intervention

Turkish results

In the HC group, HbA1c (0.8%) and periodontal treatment needs (CPI) significantly decreased compared with the HE group (*Table 3*), ($P < 0.05$). The prevalence of good HbA1c control among the HC

Table 2 Socio-economic and clinical parameters among Turkish and Danish participants at baseline

Turkish	Health coaching		Health education		*P*
n (total = 179)*	*n*	%	*n*	%	
Education	74		101		ns
Primary school or less		54		60	
At least middle school (≤8–11 years of education)		31		23	
At least university		15		17	
Current employment	77		98		ns
Retired/not working		75		78	
Employed		25		22	
Age	72		92		ns
≤49 years		29		34	
50–59		55		41	
≥60 years		16		25	
HbA1c (Mean ± SD)	77	7.5 ± 1.5%	102	7.8 ± 1.57%	ns
CPI† (Mean ± SD)	77	2.3 ± 0.86	102	2.4 ± 1.23	ns
BMI	72	30.2 ± 5.8	99	30.9 ± 5.9	ns
Lean mass	74	57.10 ± 8.6	101	57.11 ± 8.4	ns
Body fat%	74	28.01 ± 11.9	101	28.10 ± 12.0	ns

Danish (*n* = 109)	Health coaching		Health education		*P*
	n‡	%	*n*‡	%	
Education	96		78		ns
Primary school up to 10th class		31		36	
10th class (optional)		12		7	
High school		12		13	
Technical school		16		26	
At least university		29		18	
Current employment	111		110		ns
Retired/not working		88		84	
Employed		12		16	
Age	108		104		0.001
≤49 years		36		9	
50–59 years		8		35	
≥60 years		56		56	
HbA1c (Mean ± SD)	108	7.4 ± 1.6%	104	7.5 ± 1.3%	ns
CPI (Mean ± SD)	105	4.9 ± 1.36	105	4.8 ± 1.42	ns
BMI	87	31.3 ± 5.4	111	29.9 ± 5.9	ns
Lean mass	87	57.8 ± 8.8	111	60.5 ± 8.1	ns
Body fat%	87	25.9 ± 12.1	111	26.0 ± 16.2	ns

*The total number for each variable differs because the same participants did not answer all the questions. Considering HbA1c, a few patients (*n*=4) in the HC group and in the HE (*n* = 7) group did not provide their medical records; they had them at other health care settings.

†CPI: Code = 3: shallow periodontal pockets (4–5 mm), Code 2 = Calculus, Code 1: Bleeding, Code 0 = Healthy.

‡The participants who took their HbA1c records both at baseline and post-intervention were included at the analysis. Weighted sample size; 2:3 weighting ratio for the 'education: coaching' groups is used.

participants (85%) compared with the HE participants (62%) was significantly higher ($P = 0.003$). Sixty percent of the HC participants who had poor HbA1c control at baseline were in good control post-intervention, whereas it was 29% for the HETR group ($P = 0.001$). The BMI, LM and BFP in the HC group did not significantly change ($P \geq 0.05$). No significant change was observed in BMI among the HE group but there was a dramatic change in lean mass (mean change: −2.98, SD: ±7.7, $P = 0.004$) and body fat percentage (mean change: 3.11, SD: ±8.4, $P = 0.003$).

The HC group compared with the HE group reported a significantly higher rate of 'positive change in at least one behaviour' (85% *vs.* 60%, $P = 0.001$). Eighty one percent of HC participants positively changed their tooth-brushing behaviour, whereas 53% of the HE reported a positive change in tooth-brushing behaviour ($P = 0.001$). A similar improvement was observed for physical activity (HC: 40% *vs.* HE: 15%, $P = 0.001$). All HC patients who reported brushing 'twice daily' were more likely to be physically active (91%) than 'once a day or less' toothbrushing (69%), ($P < 0.05$).

Principal component analysis showed that HbA1c, CPI and 'behaviour change' share a common cluster both in the Turkish HC and the HE groups (*Table 4*).

Danish results

In the HC group, HbA1c and CPI, as observed in the Turkish group, were also significantly improved compared with the HE group (*Table 3*), ($P < 0.05$). No significant change was observed in the other clinical parameters (BMI, LM and BFP) in both the HC and the HE group participants ($P \geq 0.05$).

No significant difference for 'positive change in at least one behaviour' was reported between the HC and HE participants ($P \geq 0.05$). Specifically, the HC group participants reporting physical inactivity at baseline were more likely to be active (54%) at post intervention compared with those in the HE group (44%), ($P = 0.042$). Likewise the Turkish HC group, all HC patients who reported brushing 'twice daily' were more likely to be physically active (87%) than 'once a day or less' toothbrushing (67%), ($P < 0.05$). Three clusters were formed for the Danish HC group; respectively HbA1c and CPI, LM and BFP, 'behaviour change' (*Table 4*).

DISCUSSION

The current study evaluates the impact of an individualised HC intervention compared with an HE approach internationally, by integrating patient self-empowerment to adopt healthier lifestyles among the type 2 diabetes patients. Significant improvements were observed in HbA1c and periodontal health (CPI) both in Turkey and Denmark. Positive behavioural change was observed in both the HC groups.

HbA1c can be defined as an objective measure for lifestyle behaviour change. Regular monitoring of HbA1c values which is measured in clinical settings is now the principal way to measure and track long-term glycaemic control objectively in diabetes[42]. Knowledge, attitude and motivation are the most important for the patients' ability to make behavioural changes to maintain or reduce HbA1c levels[42]. In the present study, the HC groups compared with the HE groups significantly enhanced their lifestyles in line with the significantly higher improvement in HbA1c.

The findings showed that the variable 'behaviour change' shared the same cluster with HbA1c and CPI in the Turkish groups; that may suggest a synergistic interaction between health, oral health and their related behaviours. The HC group compared with the HE group reported a significantly higher rate of 'positive change in at least one behaviour'

Table 3 Change in HbA1c (%) and CPI among Turkish and Danish participants, specified by the health coaching and health education groups

	Health coaching group				Health education group				*P* (HC-HE post intervention)
	Baseline	Post-intervention	Mean change	*P*	Baseline	Post-intervention	Mean change	*P*	
Turkish									
HbA1c (%)	7.5	6.7	**0.8**	**0.001**	7.8	7.7	0.01	NS	**0.001**
CPI	2.3 ± 0.9	0.6 ± 0.9	1.7	0.001	2.4 ± 1.2	1.9 ± 1.5	0.5	0.001	**0.001**
Twice daily toothbrushing (%)	32	70	–	**0.001**	22	25	–	NS	**0.001**
Danish									
HbA1c (%)	7.4	7.0	**0.44**	**0.001**	7,4	7,4	0.0	NS	**0.012**
CPI	2.9 ± 0.6	1.7 ± 0.9	1.2	0.001	2.9 ± 0.7	2.3 ± 1.1	0.6	0.001	0.004
Twice daily toothbrushing (%)	65	71	–	NS	67	72	–	NS	NS

There was statistically no significant difference between HC and HE groups at baseline in terms of HbA1c and CPI.
Significant mean changes in the HC coaching group are highlighted in bold.

Table 4 Factor analysis using Varimax rotated solution to assess interrelated clusters of HbA1c at post-intervention, considering the oral health and behavioural factors among Turkish and Danish participants with type 2 diabetes[†]

(a) Turkish health coaching group	Cluster	
	Health	Body composition
HbA1c	0.717	0.458
CPI	0.829	*
Body fat percentage	*	0.835
Lean mass	*	−0.831
Behaviour change	−0.333	*

(b) Turkish health education group	Cluster	
	Health	Body composition
HbA1c	0.830	*
CPI	0.754	*
Body fat percentage	*	0.850
Lean mass	*	−0.870
Behaviour change	−0.525	*

(c) Danish health coaching group	Cluster		
	Health	Health behaviour	Body composition
HbA1c	0.863	*	*
CPI	0.811	*	*
Body fat percentage	*	*	0.975
Lean mass	*	0.835	*
Behaviour change	*	0.847	*

(d) Danish health education group	Cluster		
	Health	Health behaviour	Body composition
HbA1c	0.927	*	*
CPI	*	0.710	*
Body fat percentage	0.400	*	0.649
Lean mass	*	*	−0.786
Behaviour change	*	−0.762	*

(a) The clusters in the study group, in total, accounted for 58.4% of the total variance (composed of component 1 with 32.1% and component 2 with 26.3%).
(b) The clusters in the study group, in total, accounted for 62.1% of the total variance (composed of component 1 with 31.3% and component 2 with 30.8%).
(c) The clusters in the study group, in total, accounted for 78.7% of the total variance (composed of component 1 with 28.2% and component 2 with 29.5%, component 3 with 20.9%).
(d) The clusters in the study group, in total, accounted for 72.0% of the total variance (composed of component 1 with 22.2% and component 2 with 27.9%, component 3 with 21.9%).
*Loadings below 0.30 were not shown for ease of communication.
[†]The clusters are named based on the variable with the highest loading. As BMI was highly correlated with body fat percentage (r_s = 0.869), it was not included in the analysis.

and an improvement in HbA1c and CPI. This may be explained as a positive health transformation in the HC group by increased self-awareness and empowered self-management skills via HC that could improve health holistically. It is noteworthy that HbA1c and CPI also shared the same cluster in the Danish HC group. Regarding the similar findings in the Turkish HC group, this could be explained by the health coaching used in the present study enabled the participants to see the whole picture of a healthy lifestyle, namely interlinking the connection between health, oral health and their related behaviours. This may also be an explanation for the higher reduction CPI among the HC patients in comparison with the HE group; the intervention among the HC participants seems to be more effective in stabilising the long-term effect of periodontal cleaning. The HC group participants were motivated and supported to explore and to activate their potential to attain multiple healthy behaviours in their self-management routines, and thus may lead to improvement in periodontal health and glycaemic control; this is in line with earlier studies that showed that taking part in an intervention focusing on empowerment for diabetes self-management had a positive and sustainable impact on the management of health behaviours and glycaemic control[48,49].

Studies have shown that the coaching groups compared with the control groups significantly reduced the body-weight and fat and coronary heart disease factors including BMI[50,51]. In line with these studies, the Turkish HC group significantly reduced body fat percentage and improved the lean mass. This may be because patient empowerment takes precedence and the patient explores his/her strengths to adjust healthy lifestyles during coaching sessions. A significant improvement in physical activity and tooth-brushing can enable an improvement in body composition. Our earlier study has shown that tooth-brushing could be a trigger to enhance physical activity, that patients found it easier to adjust and shortly saw positive health outcomes such as non-bleeding gums or a nice mouth odour[43]. A successful outcome in one behaviour can increase self-confidence which may lead to adjustment of other health behaviours such as physical activity. In the present study, at post-intervention all HC patients who were 'twice daily' toothbrushers, reported physical activity at a higher rate than the 'once a day or less' toothbrushers ($P < 0.05$). This in line with studies showing that an individual adopts health behaviours, inclusive of oral health, as separate clusters, either as health-enhancing or health detrimental[44–46].

One of the limitations of the present study is the heterogeneity in the socioeconomic characteristics of the Danish group. Health coaching could work via different pathways and the outcomes may differ between different ethnic groups due to cultural and social norms. That may be one explanation for no significant change in body composition and also different pathways of correlation between body composition, health

and health behaviours in the Danish groups, as all participants were analysed as one group – Danish – regardless of their ethnic background. However, the scope of the present paper was to assess the impact of HC in comparison with HE by the use of clinical and subjective variables at an international level, regardless of ethnic or cultural differences. Furthermore, the respective studies in the field are scarce, and to our knowledge there have been no international studies assessing HC as an intervention nor any studies exploring the impact of HC compared with HE by clinical and subjective measures. Further studies are required in the field so that HC could be a complementary approach in clinics to support the clinical interventions for oral health and diabetes management.

Another limitation is that the interaction between HbA1c and CPI has not been assessed further, it may be due to biological and/or behavioural factors. Studies measuring the two-way relationship between periodontal health and HbA1c, and the impact of behavioural interventions on HbA1c and periodontal health, mostly have small sample sizes, as discussed earlier[22]. The objective of the current study was to evaluate internationally the impact of a specifically designed HC intervention on diabetes- and oral health management for participants with DM2. Furthermore, periodontal cleaning can be assessed as a confounding factor; that was standard for all participants. The rationale for periodontal cleaning is that the cleaning provided a baseline for all participants to evaluate the impact of HC *versus* HE in stabilising the long-term effect of the periodontal cleaning[22]. Additionally, the periodontal cleaning sessions were aimed to be used as an incentive to facilitate the patients' understanding of what periodontal disease is and how it is interrelated with DM2. This was done by explaining the outcomes of the periodontal examination leading to a standardised knowledge about periodontal disease and DM2, and to an extrinsic motivation so that the HC patients were encouraged to a greater use of dental services. The HC patients were the decision makers in choosing which health behaviours they want, so the HC patients were neither imposed nor specifically motivated for any particular health behaviour such as the use of health care services.

The self-reported measures in the present study can be seen as a limitation, prone to respondent bias. Assessment of the prevalence of health behaviours as part of research is vitally important and often requires the use of self-report measures. There is an inherent error risk in self-reported measures, however, if this error were constant over time, it could still be used as a good comparison criterion among epidemiological studies[16,51]. The present study could have minimised this limitation; self-reported measures were assessed over time and also analysed along with clinical measures. The improvement of both behaviours and relevant clinical measures over time may also minimise the bias.

The fact that data came from two very different socio-cultural settings can be assessed both as a limitation and a strength of the study. Individualist cultures such as the Danish cherish individualistic values such as self-reliance, self-autonomy and self-achievement[52,53] whereas, in the collectivist cultures such as the Turkish, the opposite of individualistic, people from birth are integrated into strong and cohesive groups; throughout people's lifetimes they continue to protect them in exchange for unquestioning loyalty[53]. Coaching focuses on improving all individualistic values with which the Turkish HC participants were unfamiliar, whereas the Danish participants had grown up with them. The significant improvement in HbA1c, periodontal health and health behaviours in both the Turkish and the Danish HC groups can underline that coaching works effectively with the individual values, regardless of cultural differences; thereby most probably having a positive impact on the self-management of health. However, there is a need for further studies to explore the cultural-generalisability of coaching.

The present study, as discussed earlier[22], has strength such as the long follow-up, a structured and accredited HC framework, a specifically trained health coach, multidisciplinary approach and international implementation.

There is a common global consensus on certain factors contributing to the successful management and the prevention of further complications of DM2. Health coaching can be an effective approach to achieve these factors under one umbrella. First, primary health-care systems should be inclusive of patient-centred interventions focusing not only on clinical outcomes but also on positive lifestyle changes, in order to achieve the long-term positive and sustainable changes at an earlier stage before there is a need for costly treatments. Secondly, patients need to be actively engaged in decision making and they need to feel motivated and responsible for participating in their own health-care. Doing so will lead to a requirement for support by health professionals. Thus, health professionals need to improve their competencies and skills about 'how' to motivate and encourage the patients to take the lead and have active participation in the maintenance and improvement of their health. 'How' can be implied in facilitating the patients to explore and unlock the internal self-resources and then engage in action and positive lifestyle changes to adopt and maintain health. Health coaching is a person centred approach focusing on facilitating patient engagement and activation towards the self-identified health goals by enabling and

supporting the person to explore and use own resources actively in daily life.

In health coaching, patients are the experts and the primary sources for development of personal strategies relevant to oral health- and diabetes-related behaviour and lifestyle changes. This differs substantially from the traditional oral health- and diabetes education whereby the dentist/physician is the expert who usually provides standardised information for all patients (*Table 4*). The coach always makes a request before offering advice/information, reflecting and empowering the idea that the patient is in control and also facilitating the patient's resourcefulness to make decisions and to learn. Moreover, the transfer of knowledge is designed specifically for the patient's goals; these must be in accordance with the patient's needs, expectations and daily life. It may be summarised that HC is a personalised, future oriented, self-exploring journey in which the patient is guided and motivated by the coach. Health education is usually about giving standardised health advice based on external motivation with the patient passively participating. All this could explain how health coaching can be more effective than health education.

Dentists and diabetes professionals undergo extensive training to learn and to practise 'what is best' for their patients, however this traditional training mostly focuses on 'how' to achieve the 'best' in respect to the medical perspective, usually missing the other leg, namely the perspective of the patient-collaborative partner in the medical process. Health coaching can be one of the most effective ways to achieve the 'how' completely and thereby to achieve positive outcomes at earlier stages of DM2, before costly expenses arise both for health-care systems and patients (e.g. financial cost, severe complications).

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Conflict of interest

The authors have no relevant conflict of interest to disclose.

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