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Effects of the MyDiPP Mobile App on Health-Related Quality of Life Among Adults at Risk for Type 2 Diabetes: A Randomised Controlled Trial

(Kesan Aplikasi Mudah Alih MyDiPP terhadap Kualiti Hidup Berkaitan Kesihatan dalam Kalangan Dewasa yang Berisiko terhadap Diabetes Jenis 2: Kajian Rawak Terkawal)

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Abstract

The rising rates of type 2 diabetes mellitus (T2DM) pose a major health challenge, especially for adults at high risk of developing the disease. Without early intervention, a substantial proportion of these individuals will eventually develop the disease, diminishing their quality of life, leading to limitations in daily activities and elevated psychological distress. Mobile health (mHealth) interventions such as the MyDiPP application have been proposed as a potential tool to support diabetes prevention; however, evidence on their effects on HRQoL in high-risk populations remains limited. This study aimed to evaluate the effect of the MyDiPP mobile application intervention on the HRQoL among adults at high risk of developing T2DM. This randomised controlled trial (RCT) involved 112 high-risk adults from Kuala Terengganu, Terengganu, Malaysia. They were randomly assigned to either the MyDiPP mobile application intervention group (n=56) or a control group (n=56) receiving standard health education. Changes in HRQoL at 6 and 12 months were analysed using repeated measures ANCOVA with an intention-to-treat (ITT) approach. Findings showed limited improvements across HRQoL domains following the MyDiPP intervention, particularly in role emotional (RE) and the mental component summary (MCS), reflecting a mild but encouraging influence on HRQoL. Therefore, further research is required to determine whether larger-scale studies can yield more substantial outcomes.

Keywords: Diabetes prevention; lifestyle intervention; mobile apps; obesity; quality of life

Abstrak

Peningkatan kadar diabetes melitus jenis 2 (T2DM) menjadi cabaran kesihatan yang utama, khususnya dalam kalangan orang dewasa yang berisiko tinggi untuk menghidap penyakit ini. Tanpa pelaksanaan intervensi awal, sebahagian besar individu ini berkemungkinan besar akan menghidap penyakit tersebut, sekali gus akan menjejaskan kualiti hidup mereka, membataskan aktiviti harian, serta meningkatkan tekanan psikologi. Intervensi kesihatan mudah alih (mHealth), seperti aplikasi mudah alih Program Pencegahan Diabetes Malaysia (MyDiPP), berpotensi menawarkan pendekatan inovatif untuk meningkatkan kualiti hidup berkaitan kesihatan (HRQoL) dengan menyediakan sokongan yang mudah diakses untuk pencegahan diabetes. Matlamat kajian ini adalah untuk menilai kesan intervensi aplikasi mudah alih MyDiPP terhadap HRQoL dalam kalangan orang dewasa yang berisiko tinggi untuk menghidap T2DM. Kajian rawak terkawal (RCT) ini melibatkan 112 orang dewasa berisiko tinggi dari Kuala Terengganu, Terengganu, Malaysia. Mereka diagihkan secara rawak kepada kumpulan intervensi aplikasi mudah alih MyDiPP (n=56) atau kumpulan kawalan (n=56) yang menerima pendidikan kesihatan standard. Perubahan dalam HRQoL pada 6 dan 12 bulan telah dianalisis menggunakan pengukuran berulang ANCOVA dengan pendekatan niat untuk merawat (ITT). Dapatan menunjukkan peningkatan yang terhad dalam domain HRQoL selepas intervensi aplikasi mudah alih MyDiPP, terutamanya dalam emosi peranan (RE) dan ringkasan komponen mental (MCS), yang mencerminkan pengaruh yang sederhana tetapi menggalakkan terhadap HRQoL. Oleh itu, penyelidikan lanjut adalah diperlukan bagi menentukan sama ada kajian berskala besar dapat menghasilkan keputusan yang lebih baik.

Kata kunci: Pencegahan diabetes; intervensi gayahidup; aplikasi mudah alih; obesiti; kualiti hidup

INTRODUCTION

Over the past few decades, type 2 diabetes mellitus (T2DM) has seen a substantial rise in prevalence worldwide, becoming a critical public health issue across both developed and developing nations (Nurul Fatihah et al. 2022; Okemah et al. 2018). Defined by elevated blood glucose levels due to a combination of insulin resistance and diminished insulin production, this metabolic condition is no longer predominantly observed in affluent nations; it now imposes a growing health and economic burden on low- and middle-income countries as well (Dutt et al. 2022). Recent estimates suggest that approximately 463 million individuals globally are affected by diabetes, and this figure is projected to increase to nearly 700 million by 2045 (Majety et al. 2023).

This rising incidence is strongly associated with declining physical activity, increased consumption of processed foods and sugar-sweetened beverages, and the global surge in obesity rates (Olokoba et al. 2012). These behavioural and dietary shifts are largely driven by urbanisation and socioeconomic transition that have contributed to the pathophysiological processes underlying insulin resistance and pancreatic beta-cell dysfunction (Forouhi & Wareham 2014).

Malaysia reflects this global trend, registering the highest prevalence of T2DM in Southeast Asia (Lasano et al. 2019). The country's rapid urbanisation and industrialisation have markedly transformed lifestyle behaviours, contributing to the burden of non-communicable diseases (Khoo et al. 2020). Sedentary lifestyles and increasing obesity rates, in particular, have exacerbated the epidemiological shift toward chronic metabolic disorders (Khoo et al. 2020).

Adults at elevated risk for T2DM often experience a considerable decline in health-related quality of life (HRQoL) (Alfian et al. 2016). This deterioration stems from the psychological distress of knowing one's risk status, compounded by the challenge of adhering to recommended behavioural changes and the presence of early metabolic abnormalities. The need for sustained lifestyle adjustments such as dietary regulation, physical activity, and glucose monitoring can disrupt social functioning, induce emotional fatigue, and diminish self-esteem, all of which contribute to reduced HRQoL (Papadopoulou 2015; Arslanian et al. 2018).

In this context, mobile health (mHealth) interventions have emerged as promising tools in the prevention of T2DM, particularly among high-risk populations (Kim et al. 2019). Leveraging the widespread availability of smartphones, these digital platforms offer personalised, scalable, and cost-effective means to promote sustained behavioural change. By delivering structured educational content, facilitating real-time self-monitoring, and enabling peer or coach support, mHealth solutions aim to foster healthier dietary and physical activity patterns (Hsueh et al. 2014; Nguyen et al. 2024).

Beyond these practical mechanisms, behavioural theory provides a complementary lens for understanding how such features may influence health-related behaviours and HRQoL. According to Baker et al. (2011), the behavioural strategies embedded in diabetes prevention programmes draw substantially on Social Cognitive Theory (SCT), which emphasises the roles of self-efficacy, reinforcement, and reciprocal determinism in supporting sustained health-related behaviours. Within the mHealth context, interactive components such as peer support, personalised feedback, and goal-setting have been theorised to facilitate engagement and motivation. In parallel, capability–opportunity–motivation processes described in the COM-B model have been used to explain how educational modules, tracking tools, social connectivity, and feedback features may support behaviour adoption (Aguiar et al., 2022; Milne-Ives et al., 2023). In this study, these frameworks are applied as a conceptual lens only; behavioural mediators such as self-efficacy, motivation, or behaviour-change processes were not directly measured and are therefore not treated as tested causal pathways. Therefore, this study was conducted to evaluate the influence of the MyDiPP mobile application on the HRQoL of individuals at elevated risk for developing T2DM.

MATERIALS AND METHODS

Study Design and Participants

The present study adopted a single-blind, parallel-group randomised controlled trial (RCT) design, conducted in Kuala Terengganu, Malaysia, from July 2020 to June 2021. The detailed trial design, methodology, and planned analyses have been previously reported (Nurul Fatihah et al. 2023), with minor amendments made to the statistical analysis, as described in the statistical analysis section. The study adhered to the Consolidated Standards of Reporting Trials (CONSORT) guidelines (Schulz et al. 2010). Ethical approval was granted by the Human Research Ethics Committee of Universiti Sultan Zainal Abidin (UHREC/2018/77), and all participants provided signed informed consent before their involvement in any research-related procedures. The trial was also prospectively registered with ClinicalTrials.gov (Identifier: NCT03997656) on 21 June 2019.

The required sample size for this study was calculated using the formula proposed by Florey (Florey 1993), with reference to data from prior research in diabetes prevention (Ibrahim et al. 2016). The calculation aimed to achieve a statistical power of 0.80 to detect meaningful differences in health-related quality of life (HRQoL) change between groups, with a two-tailed alpha level set at 0.05 and an estimated effect size (d = 0.5) based on prior diabetes prevention trials (Ibrahim et al. 2016). Accordingly, the study required a minimum of 100 participants (50 per group), accounting for a 30% dropout rate to ensure adequate statistical power for the study.

The study recruited participants from the general population through online advertisements and employed a convenience sampling method. Those who completed the Malay-translated and validated American Diabetes Association (ADA) diabetes risk test (Nurul Fatihah et al. 2022) via Google Forms, and who expressed a willingness to participate in the study, were selected (expected to be eligible). Inclusion criteria included adults aged 18 to 65 years with a body mass index (BMI) ≥23 kg/m² (World Health Organization (WHO) Expert Consultation 2004) and classified as high-risk for diabetes, either through a risk score ≥5 (Lindström et al. 2003) or HbA1c levels between 5.6% and 6.2% (38–44 mmol/mol) (Ministry of Health (MOH) 2015). Other requirements included ownership of an Android smartphone, proficiency in Malay or English, and willingness to participate in a weight management program or engage in physical activity. Exclusion criteria encompassed a clinical history of diabetes or a newly diagnosed diabetes during screening, HbA1c ≥45 mmol/mol or ≥6.3% (MOH 2015), the use of oral antidiabetic medications, participation in other weight management programs or interventional studies, adherence to a prescribed medical diet, or use of anti-obesity or diabetes treatments within the past four months. Participants were also excluded if they had a history of cardiovascular diseases within the last six months, had received treatment for cancer, dementia, probable Alzheimer's disease, or advanced arthritis, were pregnant, had given birth within the past six weeks, or planned to become pregnant within the next 12 months. Participants with liver or renal disease, hyperthyroidism, or any other condition that could interfere with their participation, such as physical disabilities or mental health disorders (including eating disorders or alcohol/substance abuse), were also excluded from the study.

Simple randomisation was performed using a computer-generated sequence by the co-investigator, assigning participants to either the intervention or control group in a 1:1 ratio. To maintain allocation concealment and avoid selection bias, the group assignments were enclosed in sealed, opaque envelopes. The co-investigator subsequently selected the next envelope in the sequence to be distributed to a new participant, indicating which group (intervention or control) they had been allocated to and the subsequent procedures in the study.

This study employed a single-blind design to reduce detection and performance bias. Specifically, outcome assessors and data analysts were blinded to group allocation, ensuring that the measurement of HRQoL outcomes was not influenced by knowledge of treatment status. However, due to the nature of the intervention, participants could not be blinded to their group assignment, as the intervention group accessed the Malaysia Diabetes Prevention Programme (MyDiPP) mobile application while the control group received standard care through printed materials and in-person consultations. To mitigate bias, data collection was conducted by research staff who were not involved in the randomisation process and were only provided with anonymised participant codes.

Context

Participants assigned to the intervention group utilised the MyDiPP mobile application, which provided structured educational content and self-monitoring features aimed at diabetes prevention. The curriculum consisted of 22 lessons delivered over two distinct phases: an initial 6-month active period including 16 sessions centred on improving dietary habits, increasing physical activity, and preventing relapse, followed by a 6-month maintenance phase with six sessions aimed at sustaining behaviour changes. The application allowed users to complete sessions online at their own pace, engage with health coaches and peers, and track dietary intake, physical activity, and weight loss.

Meanwhile, participants in the control group were provided with standard health education through printed materials and face-to-face consultations conducted at the Universiti Sultan Zainal Abidin Medical Centre. Comprehensive details of the MyDiPP modules, along with screenshots of key app features, are available in Supplementary Appendices 1 and 2.

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APPENDICES

TABLE S1A. First 6 Months of MyDiPP Intervention Program

Social Cognitive Theory Construct Targeted	**Behaviour Change Technique**	**Module**	**Action**	**Week (Date)**
Knowledge	Providing information about health consequences Providing information about social and environmental consequences Offering tips on behaviour substitution Giving instructions on how to perform a behaviour Providing information about emotional consequences	Introduction to the Programme Be Active! Track Your Activity Eat Well Track Your Food Be More Active! Burn More Calories than You Take In Healthy Shopping and Cooking Manage Stress Find Time for Fitness Cope with Triggers Take Care of Your Heart! Take Charge of Your Thoughts Get Support Eat Well Away from Home Stay Motivated	Dietitian Physiotherapist Physiotherapist Dietitian Dietitian Physiotherapist Dietitian and Physiotherapist Dietitian Psychologist Physiotherapist Psychologist Dietitian Psychologist Psychologist Dietitian Psychologist	1 (01/07/2020) 2 (08/07/2020) 3 (15/07/2020) 4 (22/07/2020) 5 (29/07/2020) 6 (05/08/2020) 7 (12/08/2020) 8 (19/08/2020) 10 (26/08/2020) 12 (09/09/2020) 14 (23/09/2020) 16 (07/10/2020) 18 (21/10/2020) 20 (04/11/2020) 22 (18/11/2020) 24 (02/12/2020)
Self-efficacy	Encouraging negative habit reversal Encouraging positive habit formation Repetition of behaviour Behavioural practice Regulate negative emotions			
Outcome expectation	Providing information to create positive outcome expectations			
Goal-setting and -planning	Encouraging goal-setting and -planning Prompt goal-setting (behaviour and outcome) Action-planning Problem-solving/coping-planning			
Barriers and opportunities	Providing information about social and environmental consequences Providing information about emotional consequences			
Social support	Encouraging social support Providing feedback on behaviour and outcome of behaviour Providing information about social and environmental consequences			
Feedback on behaviour and on outcome of behaviour	Providing feedback on behaviour and outcome of behaviour Reviewing behaviour goals			
Self-monitoring	Encouraging self-monitoring (behaviour and outcome of behaviour) Prompt self-monitoring of behaviour and outcome of behaviour			

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TABLE S1B. Final 6 Months of MyDiPP Intervention Program

Social Cognitive Theory Construct Targeted	**Behaviour Change Technique**	**Module**	**Action**	**Week (Date)**
Knowledge	• Offering tips on behaviour substitution • Providing information about social and environmental consequences • Giving instructions on how to perform a behaviour • Providing information about emotional consequences	When Your Weight Loss Stalls	Dietitian and Physiotherapist	28 (16/12/2020)
		Steal Your Time for Fitness Break!	Physiotherapist	32 (16/01/2021)
Self-efficacy	• Maintaining negative habit reversal • Maintaining and improving positive habit formation • Repetition of behaviour • Behavioural practice • Regulate negative emotions	Eat Healthy Food that You Enjoy!	Dietitian	36 (16/02/2021)
		Get Enough Sleep		
		Get Back on Track!	Psychologist	40 (19/03/2021)
Outcome expectation	• Providing information to create positive outcome expectations	Prevent T2DM for Life!	Psychologist	44 (19/04/2021)
Goal-setting and -planning	• Renewing goal-setting and -planning • Prompt goal-setting (behaviour and outcome) • Action-planning • Problem-solving/coping-planning		Dietitian and Psychologist	48 (20/05/2021)
Barriers and opportunities	• Providing information about social and environmental consequences • Providing information about emotional consequences			
Social support	• Maintaining social support			
Feedback on behaviour and on outcome of behaviour	• Providing feedback on behaviour and outcome of behaviour • Reviewing behaviour goals • Reviewing outcome goals			
Self-monitoring	• Maintaining self-monitoring (behaviour and outcome of behaviour)			

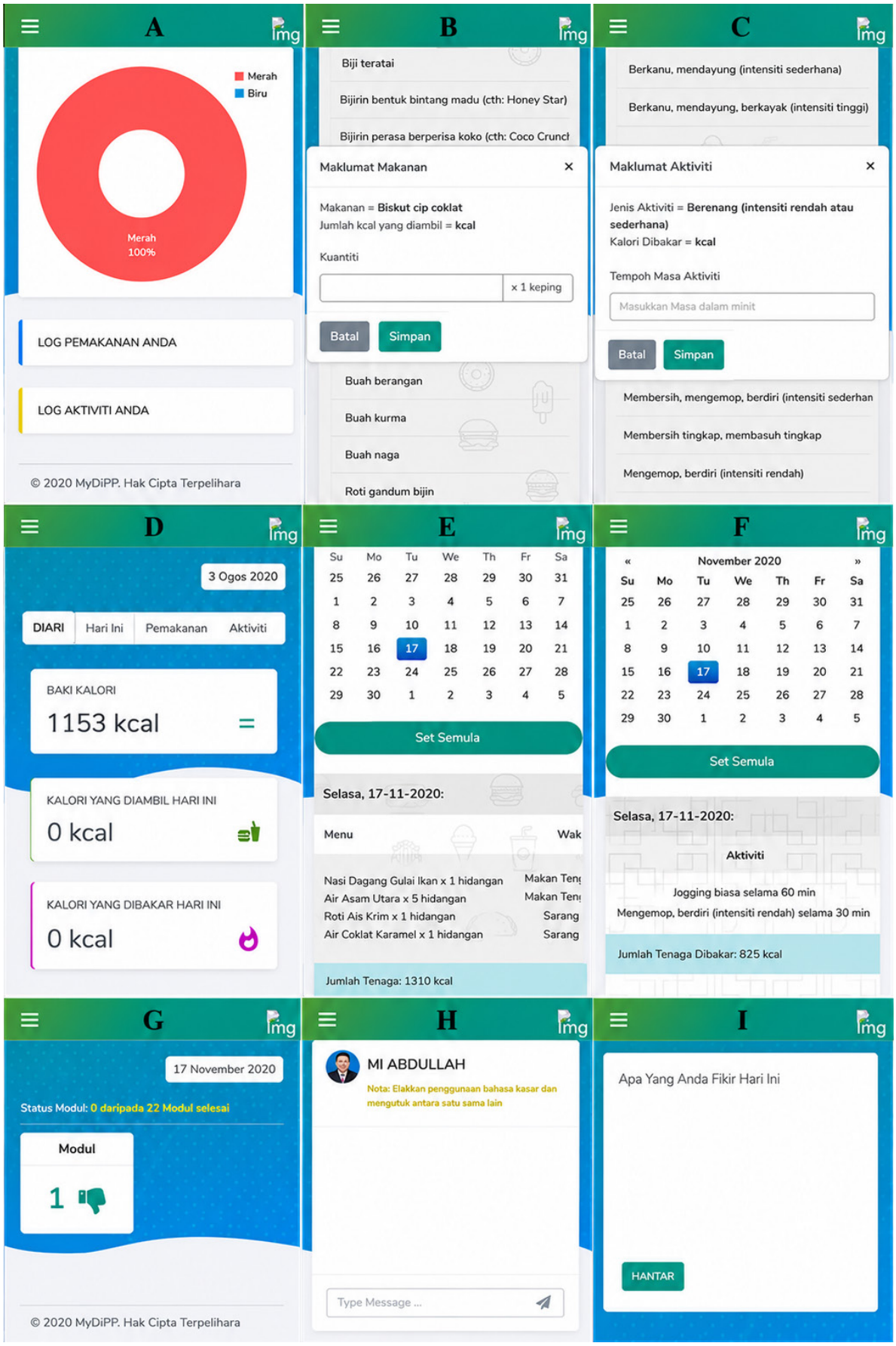

FIGURE S2A. Screenshots of MyDiPP mobile application for participants

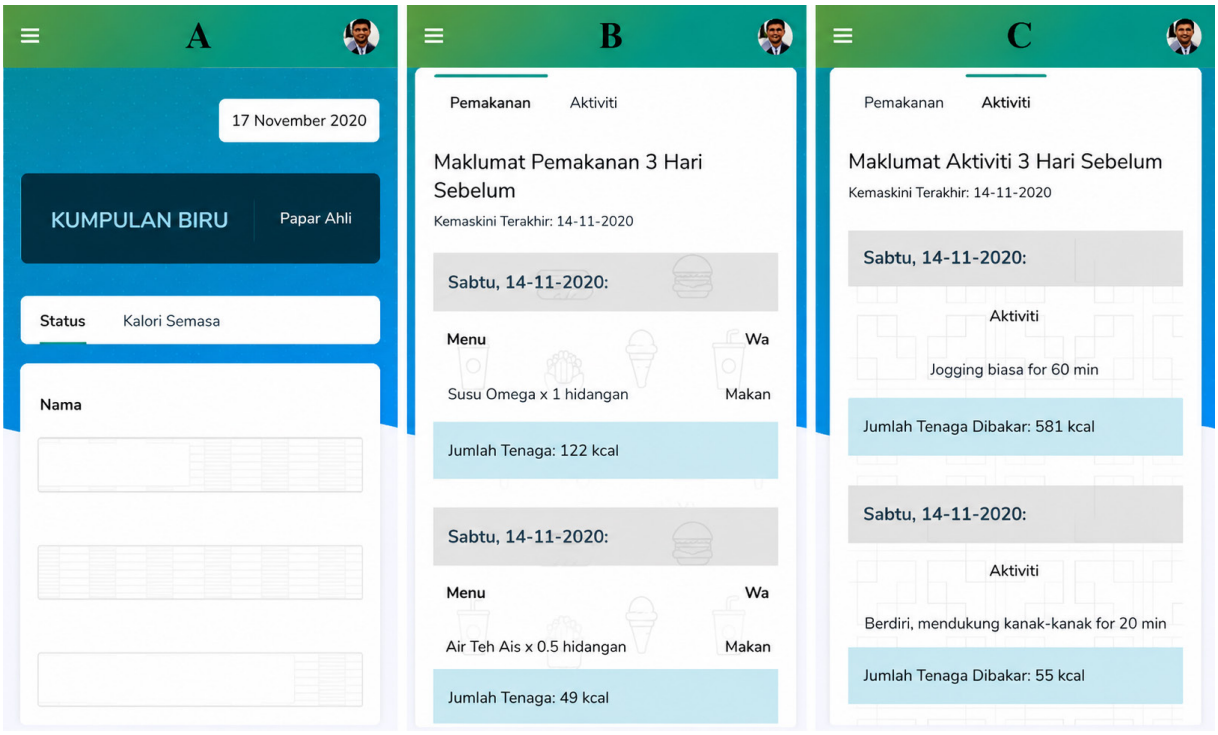

FIGURE S2B. Screenshots of MyDiPP mobile application for coaches

Data Collection and Instrument

Data on socio-demographic variables such as age, sex, ethnicity, education level (primary, secondary, or tertiary), and household income were collected. The outcome was the change in HRQoL after 6 and 12 months of intervention compared to the control group. Health-related quality of life (HRQoL) was evaluated using a validated and translated version of the Short Form-36 (SF-36) health survey (Azman et al. 2003; Sararaks et al. 2005), a widely used tool to compare quality of life across diverse populations, including healthy individuals and those with chronic diseases (Rubin & Peyrot 1999; Alonso et al. 2004). The SF-36 includes 36 items covering eight health domains: physical functioning (PF), role limitations due to physical health (RP), bodily pain (BP), general health (GH), vitality (VT), social functioning (SF), role limitations due to emotional problems (RE), and mental health (MH) (Ware & Sherbourne 1992). Each domain is scored from 0 to 100, with higher scores reflecting better health. These scores are further summarised into two summary measures: the Physical Component Summary (PCS) and the Mental Component Summary (MCS).

Statistical Analysis

All statistical analyses were performed using IBM SPSS Statistics, Version 22 (SPSS Inc., Chicago, IL, USA), with significance established at $p < 0.05$. The Kolmogorov-Smirnov test was used to assess whether the data were normally distributed. For comparing baseline characteristics between groups, an independent samples t-test was used for continuous variables with normal distribution, while the Mann-Whitney U test was applied for non-normally distributed variables. Categorical variables were analyzed using the chi-square test.

Repeated-measures ANCOVA was employed to examine changes in HRQoL over time within and between the intervention and control groups, while adjusting for potential baseline imbalance. This approach was appropriate given the two-time-point study design and the primary objective of comparing group-by-time differences after controlling for relevant covariates. Age, education level and baseline HRQoL domain scores were therefore included as covariates in the models.

The residuals were assumed to be approximately normally distributed in accordance with the Central Limit Theorem (CLT), as the sample size exceeded 30 participants per group (Kwak & Kim 2017; Norman & Streiner 2008). Outliers were evaluated and retained where theoretically justifiable, and their influence was accounted for analytically (Samdal et al. 2019). To assess the robustness of findings, attrition patterns were examined across study arms and time-points; the direction and magnitude of effects remained consistent with the primary models, indicating that attrition was unlikely to have materially affected the results. To address potential baseline imbalance, age, education level and relevant baseline HRQoL domain scores were included as covariates in the repeated-measures ANCOVA models. In addition, the study examined

attrition patterns across study arms and time-points and the direction and magnitude of effects remained consistent with the primary analysis, suggesting that attrition was unlikely to have materially altered the overall findings.

All analyses were conducted using an intention-to-treat (ITT) approach. Missing follow-up values were imputed using the last observation carried forward (LOCF) method to preserve the original randomisation structure and maintain sample comparability across groups. LOCF was selected as a pragmatic strategy given the longitudinal trial design and varying completion rates. However, we acknowledge that LOCF assumes outcome stability over time and may introduce bias in the presence of differential dropout.

Future trials of similar design should consider the use of more robust missing-data approaches, such as mixed-effects modelling or multiple imputation, which allow for the incorporation of time-varying data without relying on fixed substitution assumptions.

Given the limited sample size and the exploratory nature of the analysis, effect size statistics were not reported, as small-sample magnitude estimates may be unstable and associated with wide confidence intervals. To avoid over-interpretation, p-values and 95% confidence intervals were presented as the primary indicators of statistical evidence.

RESULTS

Participant Characteristics at Baseline

Figure 1 presents the CONSORT diagram outlining participant flow throughout the study. A total of 112 individuals met the eligibility criteria. Of these, 69 participants completed the 6-month follow-up (intervention: n = 42; control: n = 27), and 59 participants completed the 12-month assessment (intervention: n = 36; control: n = 23). At 6 months, dropout in the intervention group was driven by loss to follow-up, withdrawal, diabetes diagnoses, and pregnancy. The usual-care group reported the same reasons, along with one cancer diagnosis. At 12 months, the intervention group's reasons for dropout remained unchanged, whereas the control group's dropouts were due only to loss to follow-up and diabetes diagnosis. Attrition rates were reported separately for each group at 6- and 12-month follow-up, together with the documented reasons for dropout (loss to follow-up, voluntary withdrawal, pregnancy, cancer diagnosis, and incident diabetes). These details provide clearer context for interpreting retention patterns across the trial.

Table 1 shows the baseline socio-demographic characteristics of participants. The average age was 43 years, and females made up a greater proportion of the sample (55.4%) compared to males (44.6%). All participants were of Malay ethnicity. In terms of education, 51.8% had completed secondary school, and 42.9% reported a household income below RM1500 per month. Statistically significant differences were noted at baseline between the two groups for age ($p = 0.001$) and education level ($p = 0.001$), with the intervention group being younger and more likely to have a tertiary education, while the control group mostly had secondary education.

Table 2 presents the participants' health-related quality of life (HRQoL) at baseline. Statistically significant differences were observed between groups for vitality (VT), role emotion (RE), social functioning (SF), mental health (MH), and mental component summary (MCS) scores, with the control group scoring higher in VT, MH, and MCS. Meanwhile, both groups had similar scores for RE and SF.

Changes in HRQoL

Tables 3 and 4 summarise changes in HRQoL scores between the intervention and control groups at 6-month and 12-month follow-ups. Although several changes did not reach statistical significance between groups, notable trends were observed, particularly for the RE and MCS domains. Across both groups, changes over time were generally small and should be interpreted as trends rather than confirmed effects. The intervention group showed a numerical increase in physical functioning (PF) at both follow-up points, whereas the control group showed a small decline; however, these differences were not statistically significant. A similar pattern was observed for role physical (RP), where the intervention group showed a modest upward trend, while the control group demonstrated a smaller increase by 12 months, again without significant between-group differences. For bodily pain (BP) and general health (GH), both groups showed positive trends, with a relatively larger increase in BP in the control group and in GH within the intervention group, although these trends did not reach statistical significance. Vitality (VT) and role emotional (RE) scores increased in both groups at 6 and 12 months, with different time-point peaks across groups, but no statistically significant group effects were observed. Social functioning (SF) declined in both groups at 6 months and diverged by 12 months, yet these differences were not significant. For mental health (MH), both groups showed increases at 6 months, followed by a reduction in the intervention group and continued improvement in the control group at 12 months; however, these changes were not statistically significant. Finally, both PCS and

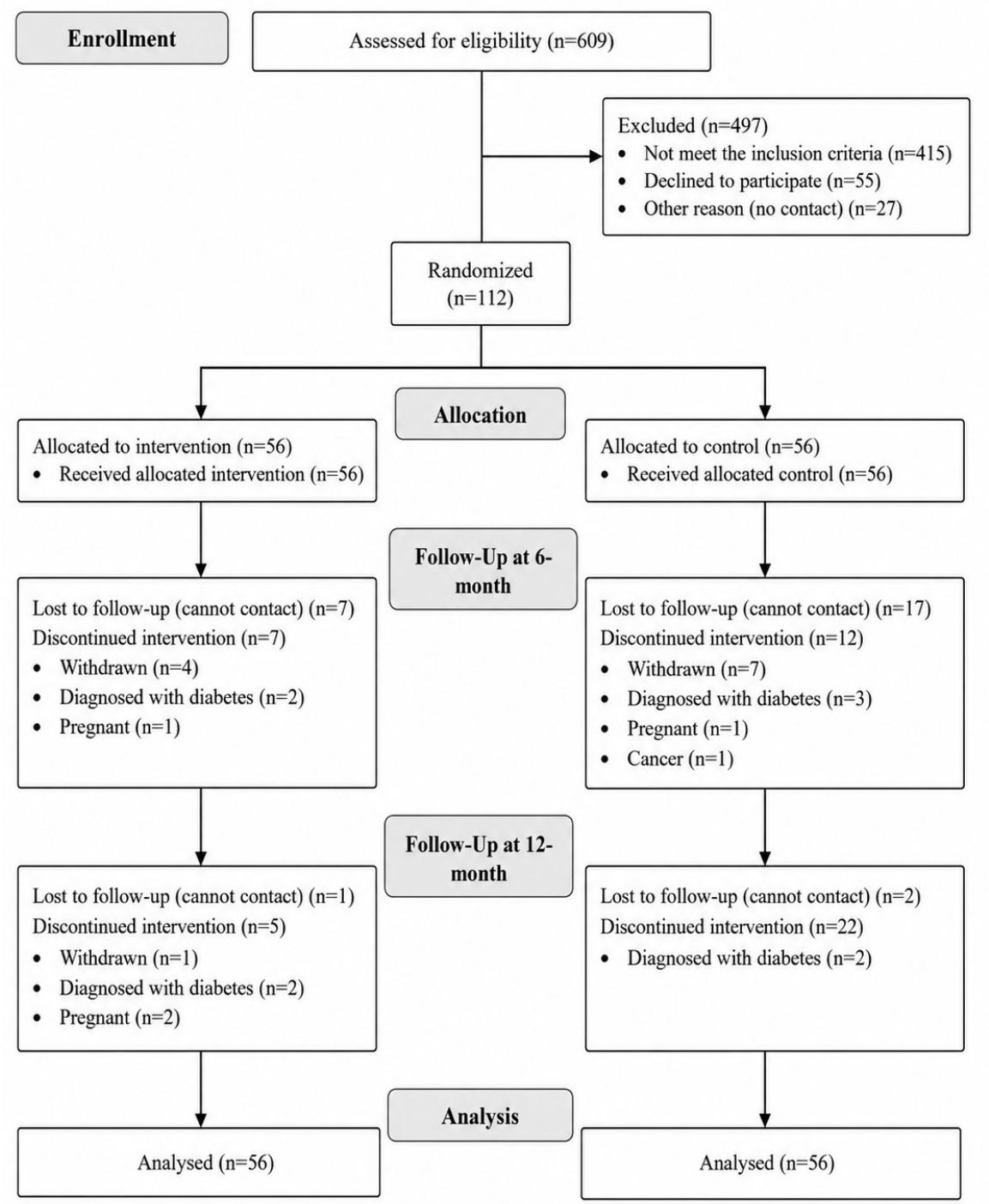

FIGURE 1. CONSORT flow diagram

MCS scores showed numerical increases over time in both groups, with differing magnitudes across domains, but no significant between-group effects were detected.

Table 5 and Table 6 present the changes in HRQoL from baseline to 6-month and baseline to 12-month follow-ups, respectively, within each treatment group. No statistically significant changes were observed in most HRQoL domains within either group, except for RE, which showed a significant increase at 6 months in both the MyDiPP (14.29, $p < 0.05$) and control groups (4.76, $p < 0.05$). Relative to the usual-care group, the MyDiPP group also demonstrated a significant increase in MCS at 6 months (16.73, $p < 0.05$).

For other domains, several non-significant trends were observed. Although PF did not significantly change within the MyDiPP group, its scores showed a numerical increase between baseline and 6 months, whereas the control group showed a declining trend. Similar upward trends were observed for RP, VT and PCS in both groups,

TABLE 1. Socio-demographic characteristics of participants at baseline

Variable	Intervention group (n=56)	Control group (n=56)	p-value	Full sample(n=112)
Age, years	37.43 (10.42)	48.52 (10.07)	0.001[a]	42.97 (11.62)
Gender; n (%)			0.128[b]	
Male	29 (51.80)	21 (37.50)		50 (44.60)
Female	27 (48.20)	35 (62.50)		62 (55.40)
Race; n (%)			NA	
Malay	56 (100.00)	56 (100.00)		112 (100.00)
Chinese	0 (0.00)	0 (0.00)		0 (0.00)
Indian	0 (0.00)	0 (0.00)		0 (0.00)
Level of education; n (%)			0.001[b]	
Primary	1 (1.80)	3 (5.40)		4 (3.60)
Secondary	17 (30.40)	41 (73.20)		58 (51.80)
Tertiary	38 (67.90)	12 (21.40)		50 (44.60)
Household income; n (%)			0.162[b]	
<RM1500	21 (37.50)	27 (48.20)		48 (42.90)
RM1500-3500	15 (26.80)	18 (32.10)		33 (29.50)
>RM3500	20 (35.70)	11 (19.60)		31 (27.70)

[a]Determine with an independent sample t-test, significant at p-value <0.05.

[b]Determine with chi-square test, significant at p-value <0.05.

TABLE 2. Health-related quality of life of participants at baseline

Characteristic	Intervention group (n = 56)	Control group (n = 56)	p-value	Full sample (n = 112)
PF	95.00 (85.00-100.00)	95.00 (90.00-100.00)	0.712[b]	95.00 (90.00-100.00)
RP	100.00 (62.50-100.00)	100.00 (75.00-100.00)	0.967[b]	100.00 (75.00-100.00)
BP	83.75 (67.50-100.00)	88.75 (77.50-100.00)	0.352[b]	87.50 (67.50-100.00)
GH	67.77 (19.65)	69.55 (15.62)	0.596[a]	68.66 (17.69)
VT	75.00 (60.00-80.00)	80.00 (66.25-95.00)	**0.004[b]**	75.00 (65.00-90.00)
RE	100.00 (33.30-100.00)	100.00 (100.00-100.00)	**0.011[b]**	100.00 (100.00-100.00)
SF	100.00 (78.13-100.00)	100.00 (100.00-100.00)	**0.048[b]**	100.00 (90.63-100.00)
MH	88.00 (76.00-92.00)	92.00 (81.00-100.00)	**0.037[b]**	88.00 (76.00-99.00)
PCS	340.00 (286.25-370.00)	348.75 (302.50-370.00)	0.610[b]	345.00 (291.88-370.00)
MCS	348.75 265.38-371.00)	368.00 (341.00-390.00)	**0.002[b]**	360.50 (313.75-379.75)

[a]Determine with independent sample t-test, significant at p-value<0.05.

[b]Determine with Mann-Whitney test, significant at p-value<0.05.

PF=Physical Functioning, RP=Role Physical, BP=Bodily Pain, GH=General Health, VT=Vitality, RE=Role Emotion, SF=Social Functioning, MH=Mental Health, PCS=Physical Component Summary, MCS=Mental Component Summary

with relatively larger numerical change values in the intervention group. In contrast, BP and MH demonstrated greater numerical increases in the control group, while changes in GH and SF were comparable across groups.

From baseline to 12 months, no statistically significant changes were detected in any HRQoL domains or summary scores. However, pattern-level variations were noted. PF, RP and PCS showed numerical increases in both groups, with relatively larger change values in the MyDiPP group. BP and GH also showed positive numerical shifts in both groups, with BP increasing more in the control group and GH increasing more in the intervention group. VT, RE and MCS displayed upward trends in both groups, whereas MH showed a decline in the MyDiPP group and an increase in the control group. For SF, scores declined in the intervention group and increased in the control group, although these differences were not statistically significant.

DISCUSSION

According to Skär et al (2014), four SF-36 subscales—physical functioning (PF), role physical (RP), bodily pain (BP), and general health (GH)—contribute to the physical component summary (PCS), while vitality (VT), social functioning (SF), role emotion (RE), and mental health (MH) contribute to the mental component summary (MCS). In this study, no significant differences were found between groups across all subscales and summary scores at 6 and 12 months before adjusting for confounders such as age, level of education and/or baseline values of health-related quality of life (HRQoL) subscales and summary scores. Within-group analyses indicated increases in RE and PCS scores, although statistically significant change was observed only for the intervention group (RE at 6 months and PCS at both time-points), while other changes represented non-significant trends. These

TABLE 3. Changes in HRQoL from baseline to six months compared between groups, mean (95% CI)

	Intervention group (n = 56)	**Control group (n = 56)**	**Mean difference (95% CI) between groups**	**p-value[a]**
*PF	1.85 (-1.43, 5.12)	-1.67 (-4.94, 1.61)	3.52 (-1.48, 8.51)	0.166
***RP**	11.54 (1.70, 21.38)	-1.27 (-11.11, 8.57)	12.81 (-2.22, 27.83)	0.094
***BP**	0.47 (-4.02, 4.97)	3.50 (-0.99, 7.99)	-3.03 (-9.88, 3.83)	0.384
***GH**	4.46 (0.27, 8.65)	1.80 (-2.40, 5.98)	2.66 (-3.73, 9.06)	0.411
****VT**	2.75 (-1.37, 6.87)	0.10 (-4.02, 4.22)	2.65 (-3.64, 8.95)	0.406
*****RE**	10.49 (4.80, 16.17)	8.57 (2.88, 14.25)	1.92 (-6.80, 10.64)	0.663
******SF**	-0.38 (-3.64, 2.89)	-0.07 (-3.33, 3.19)	-0.31 (-5.29, 4.67)	0.902
*******MH**	0.74 (-2.07, 3.55)	1.55 (-1.27, 4.36)	-0.81 (-5.10, 3.49)	0.711
***PCS**	18.31 (3.13, 33.50)	2.36 (-12.83, 17.54)	15.96 (-722, 39.14)	0.175
********MCS**	12.95 (1.38, 24.51)	10.80 (-0.77, 22.37)	2.15 (-15.69, 19.99)	0.812

[a]Determined with repeated measure ANCOVA, significant at p-value<0.05.

*Adjusted for age and level of education.

**Adjusted for age, level of education, and baseline vitality score.

***Adjusted for age, level of education, and baseline role emotion score.

****Adjusted for age, level of education, and baseline social functioning score.

*****Adjusted for age, level of education, and baseline mental health score.

****** Adjusted for age, level of education, baseline vitality, role emotion, social functioning, mental health and mental component summary scores.

CI=Confidence interval

PF=Physical Functioning, RP=Role Physical, BP=Bodily Pain, GH=General Health, VT=Vitality, RE=Role Emotion, SF=Social Functioning, MH=Mental Health, PCS=Physical Component Summary, MCS=Mental Component Summary

TABLE 4. Changes in HRQoL from baseline to 12 months compared between groups, mean (95% CI)

	Intervention group (n = 56)	Control group (n = 56)	Mean difference (95% CI) between groups	p-value[a]
*PF	0.15 (-3.47, 3.76)	-1.04 (-4.66, 2.58)	1.18 (-4.34, 6.71)	0.672
*RP	9.74 (0.61, 18.86)	4.99 (-4.13, 14.12)	4.75 (-9.19, 18.68)	0.501
*BP	0.78 (-3.45, 5.02)	2.43 (-1.80, 6.66)	-1.65 (-8.11, 4.82)	0.614
*GH	2.88 (-0.61, 6.37)	2.83 (-0.66, 6.32)	0.05 (-5.28, 5.38)	0.985
**VT	0.83 (-2.87, 4.53)	1.31 (-2.39, 5.01)	-0.48 (-6.14, 5.17)	0.866
***RE	3.69 (-4.54, 11.93)	5.83 (-2.40, 14.06)	-2.14 (-14.76, 10.48)	0.738
****SF	-0.64 (-3.25, 1.98)	0.86 (-1.76, 3.48)	-1.50 (-5.49, 2.50)	0.459
*****MH	-0.31 (-2.92, 2.30)	1.74 (-0.87, 4.35)	-2.05 (-6.03, 1.93)	0.310
*PCS	13.55 (-0.48, 27.58)	9.23 (-4.81, 23.25)	4.33 (-17.09, 25.75)	0.689
******MCS	1.61 (-10.10, 13.32)	11.71 (-0.00, 23.42)	-10.09 (-28.15, 7.96)	0.270

[a]Determined with repeated measure ANCOVA, significant at p-value<0.05.

*Adjusted for age and level of education.

**Adjusted for age, level of education, and baseline vitality score.

***Adjusted for age, level of education, and baseline role emotion score.

****Adjusted for age, level of education, and baseline social functioning score.

*****Adjusted for age, level of education, and baseline mental health score.

****** Adjusted for age, level of education, baseline vitality, role emotion, social functioning, mental health and mental component summary scores.

CI=Confidence interval

PF=Physical Functioning, RP=Role Physical, BP=Bodily Pain, GH=General Health, VT=Vitality, RE=Role Emotion, SF=Social Functioning, MH=Mental Health, PCS=Physical Component Summary, MCS=Mental Component Summary

findings should be interpreted cautiously, as age and education are known to influence HRQoL outcomes (Li et al., 2001; Wang et al., 2008). The control group was significantly older, had more with secondary education, and had higher baseline scores in VT, MH, and MCS. In contrast, the intervention group was younger, more tertiary-educated, and had lower baseline scores in those subscales, though RE scores were similar in both groups. Taken together, both age and education appear to interact in shaping HRQoL outcomes. Younger individuals tend to experience less emotional stability and mental resilience (Ware et al. 2000). In contrast, mental well-being in older adults often remains stable or even improves with age, potentially due to psychological adaptation and lowered expectations (Deaton 2007; Wang et al. 2008), although aging is commonly associated with physical decline, including reduced muscle function, decreased aerobic capacity, and changes in body composition (Janssen & Ross 2005; Chodzko-Zajko et al. 2009). Similarly, educational level also plays a key role in influencing HRQoL. Individuals with lower education tend to report lower HRQoL scores, while those with tertiary education often show higher scores, particularly in PCS and MCS scores (Göz et al. 2007; Jacobsen et al. 2018; van der Windt et al. 2008). Moreover, younger participants with higher education consistently recorded better outcomes across all SF-36 subscales as well as PCS and MCS as measured by SF-36 (Ashri et al. 2021; Jörngården et al. 2006). These trends may explain the observed improvements in PCS and RE scores within the intervention group, which included more highly educated individuals. This group is likely to practice healthier behaviours (maintain a balanced diet and engage in regular exercise), have better access to healthcare, and have higher levels of self-efficacy and support-seeking behaviour (Feng 2010;

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TABLE 5. Changes in HRQoL within groups from baseline to 6-month, mean (95% CI)

	Intervention (n = 56)				Control (n = 56)			
	Baseline	**6-month**	**Mean difference (95% CI) within groups**	**p-value[a]**	**Baseline**	**6-month**	**Mean difference (95% CI) within groups**	**p-value[a]**
***PF**	90.80 (87.32, 94.29)	92.77 (90.33, 95.20)	1.96 (-1.96, 5.89)	0.665	93.13 (90.73, 95.52)	91.34 (87.71, 94.97)	-1.78 (-5.38, 1.81)	0.675
***RP**	78.13 (67.35, 88.90)	87.50 (79.15, 95.85)	9.38 (-2.67, 21.42)	0.179	80.36 (70.81, 89.91)	81.25 (71.31, 91.19)	0.89 (-9.77, 11.56)	1.000
***BP**	81.25 (76.25, 86.25)	82.23 (78.05, 86.42)	0.98 (-4.61, 6.58)	1.000	84.11 (79.32, 88.89)	87.10 (83.00, 91.20)	2.99 (-1.73, 7.71)	0.369
***GH**	67.77 (62.55, 72.99)	70.89 (66.04, 75.75)	3.13 (-2.11, 8.36)	0.437	69.55 (65.28, 73.83)	72.68 (68.24, 77.12)	3.13 (-0.96, 7.21)	0.191
****VT**	70.63 (70.63, 70.63)	72.86 (69.65, 76.07)	2.23 (-1.73, 6.19)	0.507	79.46 (79.46, 79.46)	80.09 (75.77, 84.41)	0.63 (-4.70, 5.95)	1.000
*****RE**	73.81 (73.81, 73.81)	88.10 (81.89, 94.30)	14.29 (6.64, 21.94)	**0.001**	90.48 (90.48, 90.48)	95.24 (91.46, 99.02)	4.76 (0.10, 9.42)	**0.044**
******SF**	91.52 (91.52, 91.52)	91.30 (88.18, 94.41)	-0.22 (-4.07, 3.62)	1.000	94.64 (94.64, 94.64)	94.42 (91.52, 97.32)	-0.22 (-3.80, 3.36)	1.000
*******MH**	82.79 (82.79, 82.79)	83.21 (80.91, 85.52)	0.43 (-2.41, 3.27)	1.000	87.64 (87.64, 87.64)	89.50 (86.55, 92.45)	1.86 (-1.78, 5.49)	0.636
***PCS**	317.95 (299.02, 336.87)	333.39 (319.43, 347.35)	15.45 (-2.95, 33.84)	0.128	327.14 (311.19, 343.09)	332.37 (316.36, 348.37)	5.22 (-11.27, 21.72)	1.000
********MCS**	318.74 (318.74, 318.74)	335.46 (323.06, 346.87)	16.73 (2.65, 30.80)	**0.015**	352.23 (352.23, 352.23)	359. 25 (350.19, 368.30)	7.02 (-4.15, 18.19)	0.377

[a]Determined with repeated measure ANCOVA by group, significant at p-value<0.05.

*Adjusted for age and level of education.

**Adjusted for age, level of education, and baseline VT score.

***Adjusted for age, level of education, and baseline RE score.

****Adjusted for age, level of education, and baseline SF score.

*****Adjusted for age, level of education, and baseline MH score.

******Adjusted for age, level of education, baseline VT, RE, SF, MH, and MCS scores.

CI=Confidence interval

PF=Physical Functioning, RP=Role Physical, BP=Bodily Pain, GH=General Health, VT=Vitality, RE=Role Emotion, SF=Social Functioning, MH=Mental Health, PCS=-Physical Component Summary, MCS=Mental Component Summary

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TABLE 6. Changes in HRQoL within groups from baseline to 12-month, mean (95% CI)

	Intervention (n = 56)				Control (n = 56)			
	Baseline	**12-month**	**Mean difference (95% CI) within groups**	**p-value[a]**	**Baseline**	**12-month**	**Mean difference (95% CI) within groups**	**p-value[a]**
***PF**	90.80 (87.32, 94.29)	91.79 (88.73, 94.84)	0.98 (03.31, 5.27)	1.000	93.13 (90.73, 95.52)	91.25 (88.12, 94.38)	-1.88 (-5.86, 2.11)	0.749
***RP**	78.13 (67.35, 88.90)	86.61 (78.23, 94.98)	8.48 (-3.73, 20.69)	0.275	80.36 (70.81, 89.91)	86.61 (78.09, 95.12)	6.25 (-2.32, 14.82)	0.231
***BP**	81.25 (76.25, 86.25)	82.81 (78.34, 87.29)	1.56 (-3.49, 6.62)	1.000	84.11 (79.32, 88.89)	85.76 (81.76, 89.76)	1.65 (-3.04, 6.35)	1.000
***GH**	67.77 (62.55, 72.99)	71.07 (66.15, 76.00)	3.30 (-0.68, 7.28)	0.135	69.55 (65.28, 73.83)	71.96 (67.86, 76.07)	2.41 (-1.56, 6.38)	0.416
****VT**	70.63 (70.63, 70.63)	72.32 (68.80, 75.85)	1.70 (-2.65, 6.04)	1.000	79.46 (79.46, 79.46)	79.91 (76.65, 83.17)	0.45 (-3.58, 4.47)	1.000
*****RE**	73.81 (73.81, 73.81)	81.55 (73.46, 89.63)	7.74 (-2.23, 17.71)	0.181	90.48 (90.48, 90.48)	92.26 (85.39, 99.13)	1.79 (-6.69, 10.26)	1.000
******SF**	91.52 (91.52, 91.52)	91.07 (88.56, 93.58)	-0.45 (-3.54, 2.65)	1.000	94.64 (94.64, 94.64)	95.31 (93.11, 97.52)	0.67 (-2.05, 3.39)	1.000
*******MH**	82.79 (82.79, 82.79)	82.50 (79.55, 85.45)	-0.29 (-3.93, 3.35)	1.000	87.64 (87.64, 87.64)	89.36 (87.62, 91.09)	1.71 (-0.42, 3.85)	0.157
***PCS**	317.95 (299.02, 336.87)	332.28 (317.27, 347.28)	14.33 (-2.46, 31.12)	0.119	327.14 (311.19, 343.09)	335.58 (322.17, 348.99)	8.44 (-7.06, 23.93)	0.551
********MCS**	318.74 (318.74, 318.74)	327.44 (314.98, 339.90)	8.70 (-6.67, 24.08)	0.500	352.23 (352.23, 352.23)	356.84 (350.00, 363.69)	4.62 (-3.83, 13.06)	0.545

[a]Determined with repeated measure ANCOVA by group, significant at p-value<0.05.

*Adjusted for age and level of education.

**Adjusted for age, level of education, and baseline VT score.

***Adjusted for age, level of education, and baseline RE score.

****Adjusted for age, level of education, and baseline SF score.

*****Adjusted for age, level of education, and baseline MH score.

******Adjusted for age, level of education, baseline VT, RE, SF, MH, and MCS scores. CI=Confidence interval

PF=Physical Functioning, RP=Role Physical, BP=Bodily Pain, GH=General Health, VT=Vitality, RE=Role Emotion, SF=Social Functioning, MH=Mental Health, PCS=-Physical Component Summary, MCS=Mental Component Summary

Zhu et al. 2021). However, evidence also suggests that higher education does not always equate to better mental well-being. Study found that mental health scores may decline with increased education despite better physical outcomes (Laaksonen et al. 2007). This may help explain why the intervention group still reported lower scores in MCS, VT, and MH compared to the control group. Therefore, adjusting for these differences is crucial to prevent biased interpretations of treatment effects (Clifton & Clifton 2019).

After adjusting for the related confounders, the no significant differences in the changes in each subscale and summary scores between the groups at both intervals persisted. This agrees with the study by Wennehorst et al. (2017) that also reported after 12 months, no effect was seen on the PCS as well as MCS in the intervention group compared to the control group. Although group differences did not consistently reach statistical significance, the direction of change favoured the intervention group. Notably, within-group analyses showed statistically significant increases in RE and MCS scores in the intervention group between baseline and six months; however, these changes should be interpreted as within-group effects only, rather than evidence of intervention benefit. After covariate adjustment, the control group also demonstrated a significant increase in RE, although the magnitude of change was comparatively smaller. As the between-group differences were not statistically significant, the higher mean scores in PF, RP, GH, VT, RE, PCS, and MCS at six months and in PF, RP, GH, and PCS at twelve months among the intervention group should be interpreted with caution. These findings echo the meta-analysis by Marcos-Delgado et al. (2021), which found that lifestyle interventions targeting individuals with metabolic syndrome yielded greater HRQoL gains across several domains (PF, RP, GH, RE, and VT) compared to standard care. Similarly, Ibrahim et al. (2016) reported better improvement in PF, RP, GH, VT, RE, PCS, and MCS scores among Malaysian adults with prediabetes following a community-based lifestyle intervention compared to the usual care control group. Lifestyle intervention often involves increasing physical activity and improvement in diet (Vijayvergia & Denlinger 2015) to promote weight loss and enhance overall well-being (Webb & Wadden 2017; Wadden et al. 2020). In line with this approach, the present trial encouraged participants to engage in moderate regular physical activity and practice healthier dietary habits. Therefore, the probable explanation for this phenomenon might be due to the improvements in physical activity level among the participants in the intervention group (data not shown). This is supported by Taylor et al. (2010) and Parikh et al. (2023), who both emphasised the role of physical activity in enhancing HRQoL. A comprehensive review by Anokye et al. (2012) found that physical activity is associated with improved HRQoL regardless of whether it is self-reported or objectively measured. Numerous studies have highlighted the dual impact of physical activity on both physical and mental aspects of HRQoL (Koltyn 2001; Dachs et al. 2002; Siegel et al. 1995; Valenti et al. 2008; Wood et al. 2008). It has been linked to enhanced functional ability and independence, as well as facilitates routine activities such as bathing, getting dressed, walking, and climbing stairs (Coakley et al. 1998), and has been associated with improved outcomes in various groups including elderly, healthy adults, those with various clinical conditions, and individuals with obesity (Jepsen et al. 2013; Pucci et al. 2012). Accordingly, the intervention's influence on physical health, even in the absence of statistically significant group differences, should not be overlooked.

The observed changes in mental HRQoL domains may reflect patterns that are consistent with lifestyle-related adaptations reported in previous literature; however, these findings should be interpreted cautiously and not assumed to represent confirmed intervention effects. In contrast to large-scale studies such as Look AHEAD (Rubin et al., 2014) and other reports that did not detect mental health benefits (Florez et al., 2012; MacDonald et al., 2021), the present study observed significant improvements in MCS and RE scores within the first six months. These changes indicate short-term within-group improvements, but the absence of corresponding significant between-group differences suggests that they should be regarded as preliminary rather than confirmatory outcomes. Evidence from prior studies has suggested that physical activity may be associated with favourable mental HRQoL patterns (Mikkelsen et al., 2017; Stathopoulou et al., 2006; Gorges et al., 2010; Nicolucci et al., 2012); nevertheless, such mechanisms were not directly measured in this study and therefore cannot be inferred. One possible contextual explanation relates to baseline score differences, whereby lower initial MCS values among intervention participants may have allowed greater numerical change, a phenomenon similarly reported by MacDonald et al. (2021) and Nilsen et al. (2014) whereas higher baseline scores in the control group may have reduced the likelihood of further detectable improvement. The findings indicate that the changes observed in HRQoL scores appeared to be more evident at six months than at 12 months; however, these patterns should be interpreted cautiously, as the underlying mechanisms were not directly measured in this study. Similar temporal patterns have been reported elsewhere, where early gains in patient-reported outcomes tend to attenuate

over time (Dwibedi et al., 2022). Previous literature has suggested that short-term changes may coincide with initial engagement with digital health tools and exposure to features such as health education and self-monitoring (Abdelhameed et al., 2023; Spinean et al., 2025), whereas sustaining change over longer periods may be more dependent on continued motivation and routine integration. In line with this perspective, some studies have reported that perceived quality-of-life benefits may stabilise or diminish at longer follow-up intervals (Lavikainen et al., 2025). Declines in user engagement over time have also been documented in mHealth interventions, which may partially explain why longer-term effects are less apparent; however, such behavioural processes were not assessed in the present study and therefore cannot be inferred as causal explanations (Lavikainen et al., 2025).

Furthermore, Florez et al. (2012) reported that subjects at high risk for T2DM experienced a significant, but small improvement in the PCS, PF, GH, BP, and VT scores as a result of increased physical activity and weight loss that were accomplished through an intensive lifestyle intervention. Similarly, the Look AHEAD study (Williamson et al. 2009; Zhang et al. 2016) found positive PCS and subscale changes in T2DM patients receiving lifestyle treatment. In addition, Jepsen et al. (2013) reported positive association between physical activity and PF. It is possible that engaging in physical activity will lead to a reduction in obesity and improvement in PF, which can also make daily tasks easier to perform by enhancing gait speed, strength, physical fitness, and prompting an increased energy level (Fontaine & Barofsky 2001; Bowen et al. 2006; Villareal et al. 2011). While these studies documented measurable effects, the present study did not identify statistically significant between-group differences. The slightly higher PF, RP, GH, and PCS scores at both the 6-month and 12-month assessments, along with similarly modest within-group changes in nearly all physical domains among the intervention group, do not suggest meaningful treatment effect and should be interpreted with caution.

Moreover, social support also accounts for the improvements in HRQoL associated with weight management in overweight and obese adults at high risk for T2DM (Florez et al. 2012). Any HRQoL trends observed in the intervention group may be partly due to the social support received from peers and health coaches throughout the program. Social support has been shown to positively influence both physical and mental health by helping participants deal with the challenges of everyday life (Korpacz 2014).

Conversely, the control group reported somewhat higher BP and MH at 6 months, and higher scores in BP, VT, RE, SF, MH, and MCS at 12 months, although these differences were not statistically significant. These outcomes may reflect natural behavioural adaptations prompted by study participation alone—a phenomenon referred to as the Hawthorne effect. The awareness of being observed or monitored may have triggered healthier habits among the participants in the control group, which Lasikiewicz et al. (2014) suggested can influence psychological well-being and lead to perceived improvements. Moreover, standard care in the control group may still permit dietary and physical modifications, potentially explaining modest improvements (Lasikiewicz et al. 2014). Brodie and Slade (1990) also noted that participating in structured research can provide a sense of purpose or increased social interaction, indirectly benefiting HRQoL. However, these effects are generally less potent than those produced by active intervention.

While this study provides valuable insights into the potential of a digital diabetes prevention programme to improve HRQoL, several limitations warrant consideration. First, this study experienced attrition over the 12-month follow-up period, with higher loss to follow-up in the control group. Although an ITT framework was applied and missing data were imputed using LOCF, this approach may introduce bias because it assumes that participants' outcomes remained unchanged after their last observation. This limitation is particularly relevant in behavioural interventions, where change trajectories may differ between completers and non-completers. Nonetheless, examination of attrition patterns indicated that the direction of results was similar to the primary analysis, reducing the likelihood of major distortion in treatment effects. Future studies should incorporate statistical methods that better accommodate incomplete longitudinal data, such as mixed-effects models or multiple imputation, alongside enhanced participant-retention strategies. Beyond missing-data considerations, attrition also carries implications for intervention acceptability, statistical power, and the potential for attrition bias. The higher loss to follow-up in the control group may indicate lower engagement in the absence of ongoing digital support, whereas the sustained participation among intervention participants suggests reasonable acceptability of the MyDiPP platform among users who continued to engage. Nevertheless, the reduced sample size at 12 months limits the precision of effect estimates and findings should therefore be interpreted with caution. Future trials should incorporate stronger participant-retention strategies, including motivational features, regular follow-up prompts, and structured support contact, to sustain engagement across all study arms. In addition, effect sizes were not reported due to the small sample size and the predominance

of non-significant findings, which would have produced imprecise and potentially misleading magnitude estimates. Instead, p-values and 95% confidence intervals were prioritised to better reflect the statistical uncertainty of the results.

Second, technology literacy bias may have influenced participants' engagement with the MyDiPP app. Although smartphone ownership was a criterion for inclusion, varying levels of digital competence could have affected participants' ability to navigate the app features, complete the modules, or engage meaningfully with self-monitoring and support functions. This limitation is particularly pertinent in settings where digital health literacy is unevenly distributed across age, education, or socioeconomic strata. Future interventions should consider pre-intervention digital skills assessments and incorporate user-friendly design elements to improve usability for less tech-savvy populations.

Finally, the Hawthorne effect, whereby participants modify their behaviour due to awareness of being observed, may have contributed to the improvements observed in the control group. Participation in a structured research protocol, despite receiving only standard care, could have led individuals to adopt healthier behaviours, thereby enhancing their perceived quality of life. This phenomenon has been documented in health research and is particularly relevant in lifestyle intervention trials (McCambridge et al. 2014). While unavoidable in most behavioural studies, this effect underscores the need for incorporating objective health outcome measures and control arms that are truly inert (e.g., waitlist groups) in future trials.

CONCLUSION

This study provides preliminary insights into the potential role of a mobile-based diabetes prevention programme (MyDiPP) in supporting health-related quality of life (HRQoL) among adults at high risk of type 2 diabetes mellitus (T2DM). While several positive trends were observed, statistically significant effects were limited, and most between-group differences did not reach significance. Accordingly, the findings should be interpreted as exploratory rather than confirmatory, and they do not provide sufficient evidence to establish intervention effectiveness.

The digital delivery format suggests that programmes such as MyDiPP may be feasible and scalable as part of future prevention initiatives; however, further evidence is required before implications for routine practice or policy can be drawn. Future research should include larger, adequately powered trials, longer follow-up periods, and more comprehensive evaluation of behavioural and psychosocial mechanisms, together with economic and implementation outcomes, to determine whether the observed trends can be sustained and translated into meaningful public health benefit.

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REFERENCES

Abdelhameed, F., Pearson, E., Parsons, N., Barber, T. M., Panesar, A., Summers, C., de la Fosse, M. & Hanson, P. 2023. Health Outcomes Following Engagement With a Digital Health Tool Among People With Prediabetes and Type 2 Diabetes: Prospective Evaluation Study. *JMIR Diabetes* 8: e47224. https://doi.org/10.2196/47224

Aguiar, M., Trujillo, M., Chaves, D., Álvarez, R. & Epelde, G. 2022. mHealth Apps Using Behavior Change Techniques to Self-report Data: Systematic Review. *JMIR Mhealth Uhealth* 10(9): e33247. doi: 10.2196/33247

Alfian, S. D., Sukandar, H., Lestari, K. & Abdulah, R. 2016. Medication Adherence Contributes to an Improved Quality of Life in Type 2 Diabetes Mellitus Patients: A Cross-Sectional Study. *Diabetes Therapy* 7(4): 755. https://doi.org/10.1007/s13300-016-0203-x

Alonso, J., Ferrer, M., Gandek, B., Ware, J. E. Jr., Aaronson, N. K., Mosconi, P., Rasmussen, N. K., Bullinger, M., Fukuhara, S., Kaasa, S. & Leplege 2004. A Health-related quality of life associated with chronic conditions in eight countries: results from the International Quality of Life Assessment (IQOLA) Project. *Quality of Life Research* 13: 283–298.

Anokye, N. K., Trueman, P., Green, C., Pavey, T. G. & Taylor, R. S. 2012. Physical activity and health related quality of life. *BMC Public Health* 12: 624. https://doi.org/10.1186/1471-2458-12-624

Arslanian, S., Bacha, F., Grey, M., Marcus, M. D., White, N. H. & Zeitler, P. 2018. Evaluation and Management of Youth-Onset Type 2 Diabetes: A Position Statement by the American Diabetes Association. *Diabetes Care* 41(12): 2648. American Diabetes Association. https://doi.org/10.2337/dci18-0052

Ashri, M. H. M., Saad, H. A., Adznam, S. N. A. & Adznam, S. N. A. 2021. Factors Associated with Health-Related Quality

of Life among Government Employees in Putrajaya, Malaysia. *International Journal of Environmental Research and Public Health* 18: 2626. https://doi.org/ 10.3390/ ijerph18052626

Azman, A. B., Sararaks, S., Rugayah, B., Low, L. L., Azian, A. A., Geeta, S. & Tiew, C. T. 2003. Quality of life of the Malaysian general population: results from a postal survey using the SF-36. *Medical Journal of Malaysia* 58(5): 694-711.

Baker, M. K., Simpson, K., Lloyd, B., Bauman, A. E., & Singh, M. A. 2011. Behavioral strategies in diabetes prevention programs: a systematic review of randomized controlled trials. *Diabetes Research and Clinical Practice* 91(1): 1-12. doi: 10.1016/j.diabres.2010.06.030

Bowen, D. J., Fesinmeyer, M. D., Yasui, Y., Tworoger, S., Ulrich, C. M., Irwin, M. L., Rudolph, R. E., LaCroix, K. L., Schwartz, R. R. & McTiernan, A. 2006. Randomized trial of exercise in sedentary middle aged women: effects on quality of life. *International Journal of Behavioral Nutrition and Physical Activity* 3: 34. doi: 10.1186/1479-5868-3-34

Brodie, D. A. & Slade, P. D. 1990. Dietary versus health life style interventions in the treatment of obesity. Resultant changes and the predictions of outcome. *Psychology and Health* 4(4): 319-331. doi: 10.1080/08870449008400400

Chodzko-Zajko, W. J., Proctor, D. N., Singh, M. A. F., Minson, C. T., Nigg, C. R., Salem, G. J. & Skinner, J. S. 2009. Exercise and physical activity for older adults. *Medicine and Science in Sports and Exercise* 41(7): 1510–1530.

Clifton, L. & Clifton, D. A. 2019. The correlation between baseline score and post-intervention score, and its implications for statistical analysis. *Trials* 20: 43. https://doi.org/10.1186/s13063-018-3108-3

Coakley, E. H., Kawachi, I., Manson, J. E., Speizer, F. E., Willett, W. C. & Colditz, G. A. 1998. Decline in physical functioning with increasing body weight among middle-aged and older women. *International Journal of Obesity and Related Metabolic Disorders* 22: 958-965.

Dachs, J. N., Ferrer, M., Florez, C. E., Barros, A. J., Narváez, R. & Valdivia, M. 2002. Inequalities in health in Latin America and the Caribbean: descriptive and exploratory results for self-reported health problems and health care in twelve countries. *Pan American Journal of Public Health* 11(5-6): 335-55. doi: 10.1590/s1020-49892002000500009

Deaton, A. 2007. Income, aging, health and wellbeing around the world: Evidence from the Gallup World Poll. National Bureau of Economic Research.

Dutt, C., Salles, J. E. N., Joshi, S., Nair, T., Chowdhury, S., Mithal, A., Mohan, V., Kasliwal, R. R., Sharma, S., Tijssen, J. & Tandon, N. 2022. Risk Factors Analysis and Management of Cardiometabolic-Based Chronic Disease in Low- and Middle-Income Countries. *Diabetes Metabolic Syndrome and Obesity* 451. https://doi.org/10.2147/dmso.s333787

Dwibedi, C., Abrahamsson, B. & Rosengren, A. H. 2022. Effect of digital lifestyle management on metabolic control and quality of life in aptients with well-controlled type 2 diabetes. *Diabetes Therapy* 13: 423-439. https://doi.org/10.1007/s13300-022-01214-2

Feng, H. 2010. Study on the intervention effect of group reminiscence therapy on depressive symptoms of the elderly in communities. Changsha: Central South University.

Florey, C. D. 1993. Sample size for beginners. *BMJ* 306(6886): 1181-1184. doi: 10.1136/bmj.306.6886.1181.

Florez, H., Pan, Q., Ackermann, R. T., Marrero, D. G., Barrett-Connor, E., Delahanty, L., Kriska, A., Saudek, C. D., Goldberg, R. B., Rubin, R. R; Diabetes Prevention Program Research Group 2012. Impact of lifestyle intervention and metformin on health-related quality of life: the diabetes prevention program randomized trial. *Journal of general Internal Medicine* 27(12): 1594-601. doi: 10.1007/s11606-012-2122-5

Fontaine, K. R. & Barofsky, I. 2001. Obesity and health-related quality of life. *Obesity Reviews* 2(3): 173-82. doi: 10.1046/j.1467-789x.2001.00032.x

Forouhi, N. G. & Wareham, N. J. 2014. Epidemiology of diabetes. *Medicine* 42(12): 698. Elsevier BV. https://doi.org/10.1016/j.mpmed.2014.09.007

Gorges, D., Kulzer, B., Hermanns, N. & Haak, T. 2010. Health-related quality of life in individuals with an increased risk of type 2 diabetes. *Diabetology and Metabolism* 5(S-01): P110.

Göz, F., Karaoz, S., Goz, M., Ekiz, S. & Cetin, I. 2007. Effects of the diabetic patients' perceived social support on their quality-of-life. *Journal of Clinical Nursing* 16(7): 1353-60. doi: 10.1111/j.1365-2702.2007.01472.x

Hsueh, W. A., McLellan, K. C. P., Wyne, K. & Villagomez, E. T. 2014. Therapeutic interventions to reduce the risk of progression from prediabetes to type 2 diabetes mellitus. *Therapeutics and Clinical Risk Management* 173. https://doi.org/10.2147/tcrm.s39564

Ibrahim, N., Ming Moy, F., Awalludin, I. A. N., Mohd Ali, Z. & Ismail, I. S. 2016. Effects of a community-based healthy lifestyle intervention program (Co-HELP) among adults with prediabetes in a developing country: A Quasi-experimental study. *PLoS One* 11(12): e0167123. doi: 10.1371/journal.pone.0167123.

Jacobsen, E. L., Bye, A., Aass, N., Fosså, S. D., Grotmol, K. S., Kaasa, S., Loge, J. H., Moum, T. & Hjermstad, M. J. 2018. Norwegian reference values for the Short-Form Health Survey 36: development

over time. *Quality of Life Research* 27(5): 1201-1212. doi: 10.1007/s11136-017-1684-4

Janssen, I. & Ross, R. 2005. Linking age-related changes in skeletal muscle mass and composition with metabolism and disease. *Journal of Nutrition Health and Aging* 9(6): 408.

Jepsen, R., Aadland, E., Andersen, J. R. & Natvig, G. K. 2013. Associations between physical activity and quality of life outcomes in adults with severe obesity: a cross-sectional study prior to the beginning of a lifestyle intervention. *Health and Quality of Life Outcomes* 11: 187. doi: 10.1186/1477-7525-11-187

Jörngården, A., Wettergen, L. & von Essen, L. 2006. Measuring health-related quality of life in adolescents and young adults: Swedish normative data for the SF-36 and the HADS, and the influence of age, gender, and method of administration. *Health and Quality of Life Outcomes* 4: 91. doi: 10.1186/1477-7525-4-91.

Khoo, S., Poh, B. K., Suhaimi, S. A., Chong, K. H. & Varela, A. R. 2020. Physical Activity Promotion in Malaysia: Challenges and Opportunities. *Frontiers in Public Health* 8. https://doi.org/10.3389/fpubh.2020.536239

Kim, S. E., Castro, C. M., Cho, E. H., Tsai, J. & Cousineau, M. R. 2019. Evaluation of a Digital Diabetes Prevention Program Adapted for Low-Income Patients, 2016–2018. *Preventing Chronic Disease* 16. https://doi.org/10.5888/pcd16.190156

Koltyn, K. 2001. The association between physical activity and quality of life in older women. *Womens Health Issues* 11(6): 471–480.

Korpacz, D. 2014. Effects of social support on individuals' results of 12-weeks of cardiac rehabilitation. Master Dissertation, University of Rhode Island.

Kwak, S. G. & Kim, J. H. 2017. Central limit theorem: the cornerstone of modern statistics. *Korean Journal of Anesthesiology* 70(2): 144-156. doi: 10.4097/kjae.2017.70.2.144.

Laaksonen, E., Martikainen, P., Lahelma, E., Lallukka, T., Rahkonen, O., Head, J. & Marmot, M. 2007. Socioeconomic circumstances and common mental disorders among Finnish and British public sector employees: evidence from the Helsinki Health Study and the Whitehall II Study. *International Journal of Epidemiology* 36(4): 776-86. doi: 10.1093/ije/dym074

Lasano, N. F., Hamid, A. A., Karim, R., Dek, M. S. P., Shukri, R. & Ramli, N. S. 2019. Nutritional Composition, Anti-Diabetic Properties and Identification of Active Compounds Using UHPLC-ESI-Orbitrap-MS/MS in Mangifera odorata L. Peel and Seed Kernel. *Molecules* 24(2): 320. https://doi.org/10.3390/molecules24020320

Lasikiewicz, N., Myrissa, K., Hoyland, A. & Lawton, C. L. 2014. Psychological benefits of weight loss following behavioural and/or dietary weight loss interventions. A systematic research review. *Appetite* 72: 123-37. doi: 10.1016/j.appet.2013.09.017

Lavikainen, P. T., Lehtimäki, A. V., Heiskanen, J., Luoto, R. M., Ademi, Z. & Martikainen, J. A. 2025. The Impact of Chronic Conditions on Productivity-Adjusted Life-Years in Both the Workplace and Household Settings in the General Adult Population in Finland. *Value Health* 28(3): 379-388. doi: 10.1016/j.jval.2024.09.017

Li, N. X., Liu, C. J., Li, J. & Ren, X. H. 2001. Factors that influence the quality of life of Sichuan population. *Hua Xi Yi Ke Da Xue XueBao* 32: 247-249.

Lindström, J., Louheranta, A., Mannelin, M., Rastas, M., Salminen, V., Eriksson, J., Uusitupa, M., Tuomilehto, J; Finnish Diabetes Prevention Study Group 2003. The Finnish Diabetes Prevention Study (DPS): Lifestyle intervention and 3-year results on diet and physical activity. *Diabetes Care* 26(12): 3230-6.

MacDonald, C. S., Nielsen, S. M., Bjørner, J., Johansen, M. Y., Christensen, R., Vaag, A., Lieberman, D. E., Pedersen, B. K., Langberg, H., Ried-Larsen, M. & Midtgaard, J. 2021. One-year intensive lifestyle intervention and improvements in health-related quality of life and mental health in persons with type 2 diabetes: a secondary analysis of the U-TURN randomized controlled trial. *BMJ Open Diabetes Research and Care* 9(1): e001840. doi: 10.1136/bmjdrc-2020-001840

Majety, P., Orquera, F. A. L., Edem, D. & Hamdy, O. 2023. Pharmacological approaches to the prevention of type 2 diabetes mellitus. *Frontiers in Endocrinology* 14. https://doi.org/10.3389/fendo.2023.1118848

Marcos-Delgado, A., Hernández-Segura, N., Fernández-Villa, T., Molina, A. J. & Martín, V. 2021. The Effect of Lifestyle Intervention on Health-Related Quality of Life in Adults with Metabolic Syndrome: A Meta-Analysis. *International Journal of Environmental Research and Public Health* 18: 887. https://doi.org/10.3390/ ijerph18030887

Martin, C. K., Church, T. S., Thompson, A. M., Earnest., C. P. & Blair, S. N. 2009. Exercise dose and quality of life: a randomized controlled trial. *Archives of Internal Medicine* 169(3): 269-78. doi: 10.1001/archinternmed.2008.545

McCambridge, J., Witton, J. & Elbourne, D. R. 2014. Systematic review of the Hawthorne effect: new concepts are needed to study research participation effects. *Journal of Clinical Epidemiology* 67(3): 267-77. doi: 10.1016/j.jclinepi.2013.08.015

Mikkelsen, K., Stojanovska, L., Polenakovic, M., Bosevski, M. & Apostolopoulos, V. 2017. Exercise and mental health. *Maturitas* 106: 48-56. doi: 10.1016/j.maturitas.2017.09.003

Milne-Ives, M., Homer, S. R., Andrade, J. & Meinert, E. 2023. Potential associations between behavior change techniques and engagement with mobile health apps: a systematic review. *Frontiers in*

psychology 14: 1227443. doi: 10.3389/fpsyg.2023.1227443

Ministry of Health (MOH) 2015. *Clinical Practice Guidelines (CPG) for the Management of T2DM, 5th Edition.* Ministry of Health. https://www.moh.gov.my/moh/resources/Penerbitan/CPG/Endocrine/3a.pdf.

Nguyen, V., Ara, P., Simmons, D. G. & Osuagwu, U. L. 2024. The Role of Digital Health Technology Interventions in the Prevention of Type 2 Diabetes Mellitus: A Systematic Review. *Clinical Medicine Insights Endocrinology and Diabetes* 17. https://doi.org/10.1177/11795514241246419

Nicolucci, A., Balducci, S., Cardelli, P., Cavallo, S., Fallucca, S., Bazuro, A., Simonelli, P., Iacobini, C., Zanuso, S., Pugliese, G; Italian Diabetes Exercise Study Investigators 2012. Relationship of exercise volume to improvements of quality of life with supervised exercise training in patients with type 2 diabetes in a randomised controlled trial: the Italian Diabetes and Exercise Study (IDES). *Diabetologia* 55(3): 579-88. doi: 10.1007/s00125-011-2425-9

Nilsen, V., Bakke, P. S., Rohde, G. & Gallefoss, F. 2014. Predictors of health-related quality of life changes after lifestyle intervention in persons at risk of type 2 diabetes mellitus. *Quality of Life Research* 23: 2585–2593. https://doi.org/10.1007/s11136-014-0702-z

Norman, G. R. & Streiner, D. L. 2008. More than two groups: one-way ANOVA. In *Biostatistics: the bare essentials,* edited by Hamilton ON, 77-89. Decker BC.

Nurul Fatihah, M. F., Wafa, S. W., Mohd Ibrahim, A., Bhaskar Raj, N. & Nurulhuda, M. H. 2022. Translation and validation of American Diabetes Association diabetes risk test: the Malay version. *Malaysian Journal of Medical Sciences* 29(1): 113–125. https://doi.org/10.21315/mjms2022.29.1.11

Nurul Fatihah, M. F., Wafa, S. W., Raj, N. B., Mohd Ibrahim, A., Norkhairani, A. R., Nurulhuda, M. H. & Rohayah, H. 2023. Diabetes prevention through digital therapy for high-risk individuals: Study protocol for the Malaysia Diabetes Prevention Programme (MyDiPP). *Malaysian Journal of Nutrition* 29(1): 147-162. doi: https://doi.org/10.31246/mjn-2022-0015.

Okemah, J., Peng, J. & Quiñones, M. J. 2018. Addressing Clinical Inertia in Type 2 Diabetes Mellitus: A Review. *Advances in Therapy* 35(11): 1735. https://doi.org/10.1007/s12325-018-0819-5

Olokoba, A. B., Obateru, O. A. & Olokoba, L. B. 2012. Type 2 Diabetes Mellitus: A Review of Current Trends. *Oman Medical Journal* 27(4): 269. https://doi.org/10.5001/omj.2012.68

Osborn, C. Y., Ginkel, J. R. van, Rodbard, D., Heyman, M., Marrero, D. G., Huddleston, B. & Dachis, J. 2017. One Drop | Mobile: An Evaluation of Hemoglobin A1c Improvement Linked to App Engagement. *JMIR Diabetes* 2(2). https://doi.org/10.2196/diabetes.8039

Papadopoulou, L. 2015. Depression and Quality of Life in Patients with Diabetes. *American Journal of Nursing Science* 4(2): 88. https://doi.org/10.11648/j.ajns.s.2015040201.26

Parikh, S. M., Trivedi, N., Bhende, P., Gupta, A., Bhoraniya, S., Jain, K., Joshi, H. & Contractor, H. 2023. The effectiveness of home- based physical therapy on glycemic control and quality of life in adults with prediabetes. *National Journal of Physiology, Pharmacy and Pharmacology* 13(05): 914-919.

Pucci, G. C., Rech, C. R., Fermino, R. C. & Reis, R. S. 2012. Association between physical activity and quality of life in adults. *Revista de Saúde Pública* 46(1): 166-79. doi: 10.1590/s0034-89102012000100021

Rubin, R. & Peyrot, M. 1999. Quality of life and diabetes. *Diabetes/Metabolism Research and Reviews* 15(3): 205–218.

Rubin, R. R., Wadden, T. A., Bahnson, J. L., Blackburn, G. L., Brancati, F. L., Bray, G. A., Coday, M., Crow, S. J., Curtis, J. M., Dutton, G., Egan, C., Evans, M., Ewing, L., Faulconbridge, L., Foreyt, J., Gaussoin, S. A., Gregg, E. W., Hazuda, H. P., Hill, J. O., Horton, E. S., Hubbard, V. S., Jakicic, J. M., Jeffery, R. W., Johnson, K. C., Kahn, S. E., Knowler, W. C., Lang, W., Lewis, C. E., Montez, M. G., Murillo, A., Nathan, D. M., Patricio, J., Peters, A., Pi-Sunyer, X., Pownall, H., Rejeski, W. J., Rosenthal, R. H., Ruelas, V., Toledo, K., Van Dorsten, B., Vitolins, M., Williamson, D., Wing, R. R., Yanovski, S. Z., Zhang, P; Look AHEAD Research Group 2014. Impact of intensive lifestyle intervention on depression and health-related quality of life in type 2 diabetes: the Look AHEAD Trial. *Diabetes Care* 37(6): 1544-53. doi: 10.2337/dc13-1928

Samdal, G. B., Meland, E., Eide, G. E., Berntsen, S., Abildsnes, E., Stea, T. H. & Mildestvedt, T. 2019. The Norwegian Healthy Life Centre Study: A pragmatic RCT of physical activity in primary care. *Scandinavian Journal of Public Health* 47(1): 18-27. doi:10.1177/1403494818785260.

Sararaks, S., Azman, A. B., Low, L. L., Rugayah, B. & Aziah, A. M. 2005. Validity and reliability of the SF-36: the Malaysian context. *Medical Journal of Malaysia* 60: 163– 179.

Schulz, K. F., Altman, D. G., Moher, D; CONSORT Group 2010. CONSORT 2010 statement: updated guidelines for reporting parallel group randomised trials. *BMJ* 340: c332. doi: 10.1136/bmj.c332.

Siegel, P., Brackbill, R. & Heath, G. 1995. The epidemiology of walking for exercise: Implications for promoting activity among sedentary groups. *American Journal of Public Health* 85(5): 706–710.

Skär, L., Juuso, P. & Söderberg, S. 2014. Health-related quality of life and sense of coherence among people with obesity: Important factors for health management. *SAGE Open Medicine* 2. doi:10.1177/2050312114546923

Spinean, A., Mladin, A., Carniciu, S., Stănescu, A. M. A. & Serafinceanu, C. 2025. Emerging Methods for Integrative Management of Chronic Diseases: Utilizing mHealth Apps for Lifestyle Interventions. Preprints. https://doi.org/10.20944/preprints202503.1122.v1

Stathopoulou, G., Powers, M. B., Berry, A. C., Smits, J.A. & Otto, M. W. 2006. Exercise interventions for mental health: a quantitative and qualitative review. *Clinical Psychology: Science and Practice* 13(2): 179–193. https://doi.org/10.1111/j.1468- 2850.2006.00021.x

Taylor, L. M., Spence, J. C., Raine, K., Plotnikoff, R. C., Vallance, J. K. & Sharma, A. M. 2010. Physical activity and health-related quality of life in individuals with prediabetes. *Diabetes Research and Clinical Practice* 90: 15-21.

Valenti, M., Porzio, G., Aielli, F., Verna, L., Cannita, K., Manno, R., Masedu, F., Marchetti, P. & Ficorella, C. 2008. Physical exercise and quality of life in breast cancer survivors. *International Journal of Medical Sciences* 5(1): 24-8. doi: 10.7150/ijms.5.24

van der Windt, D. A., Dunn, K. M., Spies-Dorgelo, M. N., Mallen, C. D., Blankenstein, A. H. & Stalman, W. A. 2008. Impact of physical symptoms on perceived health in the community. *Journal of Psychosomatic Research* 64(3): 265-74. doi: 10.1016/j.jpsychores.2007.10.003

Vijayvergia, N. & Denlinger, C. S. 2015. Lifestyle Factors in Cancer Survivorship: Where We Are and Where We Are Headed. *Journal of Personalized Medicine* 5(3): 243-63. doi: 10.3390/jpm5030243. PMID: 26147495; PMCID: PMC4600146.

Villareal, D. T., Chode, S., Parimi, N., Sinacore, D. R., Hilton, T., Armamento-Villareal, R., Napoli, N., Qualls, C. & Shah, K. 2011. Weight loss, exercise, or both and physical function in obese older adults. *New England Journal of Medicine* 364(13): 1218-29. doi: 10.1056/NEJMoa1008234

Wadden, T. A., Tronieri, J. S. & Butryn, M. L. 2020. Lifestyle modification approaches for the treatment of obesity in adults. *American Psychologist* 75(2): 235-251. doi: 10.1037/amp0000517. PMID: 32052997; PMCID: PMC7027681.

Wang, R., Wu, C., Zhao, Y., Yan, X., Ma, X., Wu, M., Liu, W., Gu, Z., Zhao, J. & He, J. 2008. Health related quality of life measured by SF-36: a population-based study in Shanghai, China. *BMC Public Health* 8: 292. https://doi.org/10.1186/1471-2458-8-292

Ware, J. E. Jr., Kosinski, M. & Dewey J. E. 2000. *How to Score Version 2 of the SF-36 Health Survey (Standard & Acute Forms).* QualityMetric.

Ware, J. E. & Sherbourne, C. D. 1992. The MOS 36-item short-form health survey (SF-36): I. Conceptual framework and item selection. *Medical Care* 30: 473-483.

Webb, V. L. & Wadden, T. A. 2017. Intensive Lifestyle Intervention for Obesity: Principles, Practices, and Results. *Gastroenterology* 152(7): 1752-1764. doi: 10.1053/j.gastro.2017.01.045

Wennehorst, K., Mildenstein, K., Saliger, B., Keil, T. & Englert, H. 2017. Does a holistic lifestyle intervention program improve health-related quality of life and psychological wellbeing in adults at diabetes risk? *Diabetes Management* 7(3): 256-263.

WHO Expert Consultation 2004. Appropriate body-mass index for Asian populations and its implications for policy and intervention strategies. *Lancet* 363(9403): 157-63. doi: 10.1016/S0140-6736(03)15268-3.

Williamson, D. A., Rejeski, J., Lang, W., Van Dorsten, B., Fabricatore, A. N., Toledo, K; Look AHEAD Research Group 2009. Impact of a weight management program on health- related quality of life in overweight adults with type 2 diabetes. *Archives of Internal Medicine* 169(2): 163-71. doi: 10.1001/archinternmed.2008.544

Wood, L., Shannon, T., Bulsara, M., Pikora, T., McCormack, G. & Giles-Corti, B. 2008. The anatomy of the safe and social suburb: an exploratory study of the built environment, social capital and residents' perceptions of safety. *Health Place* 14(1): 15-31. doi: 10.1016/j.healthplace.2007.04.004

Zhang, P., Hire, D., Espeland, M. A., Knowler, W. C., Thomas, S., Tsai, A. G., Glick, H. A; Look AHEAD Research Group 2016. Impact of intensive lifestyle intervention on preference-based quality of life in type 2 diabetes: Results from the Look AHEAD trial. *Obesity (Silver Spring)* 24(4): 856-64. doi: 10.1002/oby.21445

Zhu, Z., Zhu, D., Jiang, Y., Lin, Y., Yang, Y. & Luan, W. 2021. Cross-sectional study on the SF-36, the general self-efficacy, the social support, and the health promoting lifestyle of the young elderly in a community in Shanghai, China. *Annals of Palliative Medicine* 10(1): 518-529. doi: 10.21037/apm-20-2462