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From Knowing to Living Well: How Behavioural Skills Bridge the Gap Between Knowledge, Self-Management, and Quality of Life in Type 2 Diabetes

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ABSTRACT

Quality of life (QoL) in type 2 diabetes mellitus (T2DM) depends on translating knowledge and motivation into sustained self-management. This knowing–doing gap remains a central challenge in primary care, where education-focused interventions often fail to improve clinical outcomes. Using the Information–Motivation–Behavioural Skills (IMB) model, we tested pathways linking knowledge, motivation, behavioural skills, self-management, glycaemic control (HbA1c), and QoL. A cross-sectional study was conducted among 300 adults with T2DM recruited from 20 primary health centres in Nganjuk, East Java, Indonesia. Validated scales measured IMB constructs and self-management. HbA1c was obtained from records and QoL from WHOQOL-BREF. Structural equation modeling tested direct and indirect pathways, controlling for age, gender, education, income, and illness duration. The model demonstrated good fit (RMSEA=0.061, CFI=0.957, TLI=0.922, SRMR=0.040, CD=0.546). Knowledge (β=0.34, p=0.001) and motivation (β=0.28, p=0.006) were associated with behavioural skills, which strongly predicted self-management (β=0.68, p<0.001). Direct paths from knowledge (β=0.12, p=0.144) and motivation (β=0.06, p=0.423) to behaviour were non-significant. Better self-management was associated with lower HbA1c (β=-0.22, p<0.001), which was associated with higher QoL (β=-0.11, p=0.046). Income and illness duration were also associated with HbA1c and QoL. Findings support that behavioural skills bridge the knowing–doing gap by translating knowledge and motivation into effective self-management, with downstream associations with glycaemic control and QoL. Primary care should prioritize skill-building over information alone.

Keywords: IMB model; behavioural skills; diabetes self-management; HbA1c; quality of life; Indonesia

1. Introduction

Type 2 diabetes mellitus (T2DM) represents a growing global health challenge, not only for its clinical complications but for its profound impact on quality of life (QoL) (Norris et al., 2001; Bandura, 2004; American Diabetes Association, 2022). Globally, 537 million adults lived with diabetes in 2021, with projections reaching 783 million by 2045, with disproportionate increases in low- and middle-income countries (LMICs) (International Diabetes Federation, 2021). In Indonesia, prevalence among adults aged ≥15 years rose from 6.9% in 2013 to 10.9% in 2018, and East Java is among provinces with the highest burden (Badan Litbangkes, 2018). Effective management requires sustained self-

management to prevent complications and maintain QoL — daily decisions regarding diet, physical activity, medication adherence, and self-monitoring (Glasgow et al., 2007).

In this context, understanding what sustains QoL in T2DM — beyond HbA1c to include perceived physical health, psychological well-being, social relationships, and environmental adaptation — has become a central interdisciplinary challenge for quality of life research (Harper & Power, 1998; Skevington et al., 2004). Recent evidence highlights that subjective well-being in chronic illness is shaped less by clinical indicators alone than by the psychosocial resources that enable patients to live well with their condition (Skevington et al., 2004; Toobert et al., 2000).

Yet interventions in routine primary care often continue to prioritize information provision over deeper behavioural mechanisms (Michie et al., 2011). Knowledge is necessary but often insufficient for sustained health behaviour change. Patients may understand recommended practices and express strong intentions to follow them, yet struggle to translate these intentions into daily action. This discrepancy, often described as the "knowing–doing gap," is particularly evident in chronic disease management, where successful outcomes depend on the consistent performance of complex self-care behaviours (Ajzen, 1991; Gollwitzer, 1999; Sheeran, 2002; Webb & Sheeran, 2006; Schwarzer, 2008). Meta-analytic evidence shows that a medium-to-large change in intention ($d = 0.66$) engenders only a small-to-medium change in behaviour ($d = 0.36$), underscoring that motivation does not automatically translate into action (Webb & Sheeran, 2006).

The Information–Motivation–Behavioural Skills (IMB) model offers a useful framework for examining these processes (Fisher & Fisher, 1992; Fisher et al., 2003). Originally developed to explain HIV-preventive behaviour, the model proposes that health-related behaviour is determined by three key components: information (knowledge relevant to the behaviour), motivation (personal attitudes and social support), and behavioural skills (objective abilities and perceived self-efficacy to perform the behaviour). Critically, the IMB model posits that information and motivation influence behaviour primarily through behavioural skills, suggesting that individuals must be capable not only of understanding what to do and wanting to do it, but also of knowing how to implement these behaviours in real-life contexts (Fisher et al., 2003; Fisher et al., 2009; Osborn & Fisher, 2008). This distinction between intention formation and action implementation aligns with broader theories such as Gollwitzer's (1999) implementation intentions and Schwarzer's (2008) Health Action Process Approach (HAPA), which differentiate motivational and volitional phases of behaviour change.

In the context of T2DM, behavioural skills represent practical competencies such as planning balanced meals, using and interpreting blood glucose monitoring, managing medication schedules, problem-solving in challenging situations (e.g., hypo/hyperglycaemia), and integrating lifestyle recommendations into daily routines under resource constraints (Bandura, 2004; Glasgow et al., 2007; Schmitt et al., 2022). These skills represent a critical bridge between psychological readiness and actual

behaviour (Bandura, 2004; Schwarzer, 2008). However, health services — especially at the primary care level (Puskesmas) in Indonesia — often emphasise education and counselling without adequately addressing skill development (Norris et al., 2001). As a result, patients may leave consultations informed but insufficiently equipped to implement recommended behaviours.

In addition to psychological processes, diabetes outcomes are also shaped by broader social and clinical factors. Socioeconomic conditions, such as income and education, influence access to resources that support self-management, including healthy food, medications, and healthcare services (Marmot, 2005; Walker et al., 2014a). Clinical factors, such as duration of illness, may further complicate disease management and affect patients' ability to maintain glycaemic control (Stratton et al., 2000). Low income in Indonesia (mean Rp 0.95 million/month in our sample) limits capacity for dietary adherence and self-monitoring, while longer illness duration is associated with diabetes distress and treatment fatigue (Walker et al., 2014b). These influences underscore the importance of situating psychological models within a broader biopsychosocial framework that reflects the realities of patients' lived experiences (Engel, 1977), consistent with HSSC's focus on the social determinants of health-related quality of life and subjective well-being in chronic disease populations (e.g., Llorens-Ortega et al., 2024).

1. 1. Research Gap

Although information, motivation, and self-management behaviours have been linked to diabetes outcomes, important gaps remain. First, many studies test direct associations between knowledge and behaviour or motivation and behaviour, without explicitly testing behavioural skills as the mechanism through which knowledge and motivation are translated into effective self-management (Al-Qarni et al., 2022). This limits understanding of the knowing–doing gap in T2DM.

Second, prior IMB applications in diabetes are largely from high-income settings and focus on self-care as endpoint, rather than linking behavioural processes to both clinical outcomes (HbA1c) and QoL within a single structural model (Osborn & Fisher, 2008; Mayberry & Osborn, 2014). The relationship between behavioural pathways, glycaemic control, and patients' subjective well-being remains underexplored, particularly using WHOQOL-BREF which captures physical, psychological, social, and environmental domains.

Third, empirical evidence in LMIC primary care remains limited. Puskesmas in Indonesia manage 70-80% of T2DM cases, yet most IMB studies recruit from hospitals, limiting generalizability to resource-limited settings where skill-building support is most needed.

Finally, few studies incorporate social determinants (income, education, illness duration) as exogenous influences on IMB pathways, despite strong evidence that these factors shape both self-management capacity and QoL (Marmot, 2005; Walker et al., 2014a).

1. 2. Theoretical Contribution

This study contributes to QoL research in three ways. First, it advances the IMB model by applying it to T2DM management in a middle-income country primary care setting, extending its original HIV-prevention application to chronic disease self-management, consistent with HSSC's call for diverse cultural contexts.

Second, it extends stress-coping and behaviour change theory by explicitly testing behavioural skills as the central mechanism bridging intention and behaviour — demonstrating that information (β=0.336) and motivation (β=0.279) operate indirectly, with behavioural skills (β=0.684) as the strongest proximal predictor of behaviour, consistent with the volitional phase in HAPA (Schwarzer, 2008).

Third, it integrates psychosocial, clinical, and QoL outcomes within a unified biopsychosocial pathway: Information/Motivation → Behavioural Skills → Self-Management → HbA1c → Quality of Life, incorporating income, education, age, and illness duration. This addresses HSSC's interdisciplinary emphasis on how psychological resources translate into subjective well-being among individuals living with chronic illness.

1. 3. Study Objectives

Guided by the IMB model (Fisher & Fisher, 1992; Fisher et al., 2003), this study tests an integrated psychosocial pathway linking knowledge, motivation, and behavioural skills to QoL in adults with T2DM (Figure 1). Specifically, we aim to: (1) examine whether diabetes knowledge and motivation are associated with greater behavioural skills; (2) assess whether behavioural skills mediate the association between information/motivation and self-management behaviour; (3) evaluate whether self-management is associated with glycaemic control and whether HbA1c is associated with QoL; and (4) test direct and indirect associations of IMB constructs with QoL through behavioural and clinical pathways using structural equation modeling.

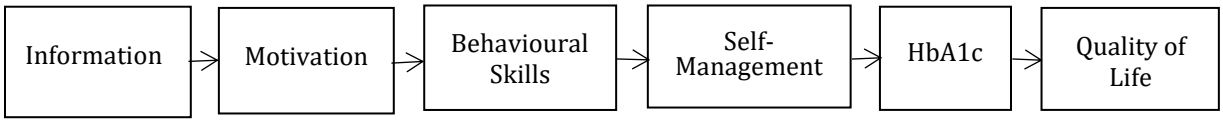


Figure 1. Conceptual Framework Based on the Information–Motivation–Behavioural Skills (IMB) Model

2. Methods

2. 1. Study design and participants

This cross-sectional study was conducted among patients with type 2 diabetes mellitus (T2DM) attending primary healthcare centres (Puskesmas) in Nganjuk District, East Java, Indonesia. The accessible population comprised adult patients receiving routine diabetes

care at these centres. A multistage sampling approach was used, in which 15 patients were randomly selected from each of 20 Puskesmas, resulting in a total sample of 300 participants (Levy & Lemeshow, 2008).

The sample size exceeded commonly recommended minimum requirements for SEM and provided an estimated participant-to-parameter ratio consistent with recommended practice (Kline, 2016).

Eligible participants were adults diagnosed with T2DM who were able to provide informed consent and complete the study questionnaire. Data collection was conducted in the healthcare setting, and participants completed structured questionnaires assessing psychological, behavioural, and quality of life variables, along with sociodemographic and clinical information.

2. 2. Explanatory Variables

The study applied the Information–Motivation–Behavioural Skills (IMB) model to assess key psychological determinants of diabetes self-management (Fisher et al., 2003).

Knowledge

Diabetes knowledge (information) was measured using a 6-item scale assessing participants' understanding of diabetes management. Within the IMB model, the information component represents the foundational requirement for behaviour change, encompassing patients' factual knowledge about the disease and their understanding of how specific behaviours—such as diet and medication adherence—affect health outcomes (Fitzgerald et al., 1998; Fisher et al., 2003; Al-Qarni et al., 2022).

Motivation

Motivation for self-management was assessed using a 6-item scale capturing both personal and social motivation to engage in recommended diabetes self-management behaviours. Within the IMB framework, personal motivation reflects individuals' attitudes toward the behaviour and their beliefs about its consequences, while social motivation refers to perceived social support and normative expectations from significant others, such as family members and healthcare providers (Fisher & Fisher, 1992; Williams et al., 1998, 2004; Osborn & Fisher, 2008; Fisher et al., 2009).

Behavioural skills

Behavioural skills were measured using a 5-item scale assessing participants' perceived ability to perform key diabetes self-management tasks across five domains: technical skills, interpretive skills, planning skills, problem-solving, and self-regulatory skills. The items captured patients' ability to plan a balanced, diabetes-appropriate diet, use a blood glucose monitor, interpret blood glucose readings, manage hypo- or hyperglycaemic episodes, and track their own health data.

Consistent with the IMB model, behavioural skills represent the functional prerequisite for action. Accordingly, the scale assessed patients' capability, proficiency, and self-efficacy in performing self-management tasks, rather than the frequency with which these behaviours were carried out (e.g., number of days exercising). This distinction reflects the conceptualisation of behavioural skills as the mechanism through which knowledge and motivation are translated into effective health behaviour (Toobert et al., 2000; Fisher et al., 2003; American Diabetes Association, 2022).

Diabetes self-management behaviour

Diabetes self-management behaviour was assessed using a 6-item scale covering six domains: dietary adherence, physical activity, blood glucose monitoring, medication adherence, foot care, and problem management. The scale captured the extent to which participants engaged in recommended self-management practices in their daily lives. Higher scores indicated more consistent adherence to these behaviours (Eroglu & Sabuncu, 2021; Schmitt et al., 2022; American Diabetes Association, 2022).

The questionnaires used to assess the IMB constructs are provided as supplementary material. All items were measured using Likert-type scales, with higher scores indicating greater levels of the respective constructs (Sullivan & Artino, 2013; Mokkink et al., 2018).

2. 3. Outcome measures

Glycaemic control

Glycaemic control was assessed using glycated hemoglobin (HbA1c) levels obtained from clinical records. Higher HbA1c values indicate poorer glycaemic control (American Diabetes Association, 2022; ElSayed et al., 2023).

Quality of life

Quality of life was measured using the World Health Organization Quality of Life instrument (WHOQOL-BREF), which assesses perceived well-being across multiple domains. Higher scores indicate better quality of life (Harper & Power, 1998; World Health Organization, 1998; Skevington et al., 2004).

2. 4. Sociodemographic and clinical variables

Sociodemographic variables included age (Kirkman et al., 2012), gender (Kautzky-Willer et al., 2016), education level (Schillinger et al., 2002), and monthly income (Walker et al., 2014a). Clinical characteristics included duration of illness (in months) (Stratton et al., 2000). These variables were included in the analysis as covariates based on their established relevance to diabetes outcomes.

2. 5. Reliability of measures

Internal consistency reliability of the study measures was assessed using Cronbach's alpha. All scales demonstrated acceptable to good reliability, with coefficients ranging from 0.74 to 0.84, supporting the internal consistency of the IMB constructs, self-management behaviour, and quality of life measures. All items were retained to preserve the integrity of the WHOQOL-BREF scale (Streiner & Norman, 2008; Tavakol & Dennick, 2011) (Table 1).

Table 1. Internal Consistency Reliability of IMB Constructs and Study Variables

A. IMB Constructs

Construct	Number of items	Item–test correlation (range)	Cronbach's α
Diabetes knowledge	6	0.60 – 0.88	0.87
Motivation for self-management	6	0.64 – 0.76	0.79
Behavioural skills	6	0.62 – 0.83	0.83

B. Self-management behaviour

Construct	Number of items	Item–test correlation (range)	Cronbach's α
Self-management behaviour	6	0.56 – 0.71	0.74

C. Quality of life (WHOQOL-BREF)

Construct	Number of items	Item–test correlation (range)	Cronbach's α
Quality of life	25	0.15 – 0.60	0.84

Note. N = 300. Item–test correlation represents the correlation between each item and the total scale score. Cronbach's alpha values indicate internal consistency reliability of the scales.

2. 6. Statistical analysis

Descriptive statistics were used to summarize participant characteristics and study variables. Structural equation modelling (SEM) was employed to examine the relationships among information, motivation, behavioural skills, self-management behaviour, glycaemic control (HbA1c), and quality of life.

The model was specified to test both direct and indirect pathways in accordance with the IMB framework, with behavioural skills hypothesized as a mediator between psychological constructs and behaviour. Sociodemographic and clinical variables were included as exogenous covariates. Because the data were cross-sectional, the estimated pathways represent hypothesized associations consistent with the IMB framework and should not be interpreted as evidence of temporal or causal relationships.

Model fit was evaluated using multiple indices, including the root mean square error of approximation (RMSEA), comparative fit index (CFI), Tucker–Lewis index (TLI), and standardised root mean square residual (SRMR). Standardized path coefficients (β) with 95% confidence intervals and p-values were reported (Hu & Bentler, 1999; Tabachnick &

Fidell, 2013; Kline, 2016). All analyses were conducted using Stata statistical software (StataCorp, 2021).

3. Results

3. 1. Sample Characteristics

The sample characteristics of the study participants are presented in Table 2. The mean age of participants was 58.28 years (SD = 7.96), with the majority being female (72.3%). Approximately two-thirds of participants had at least a high school education (66.0%). The mean monthly income was relatively low (0.95 million Rupiah; SD = 1.70), and the average duration of illness was 52.84 months (SD = 47.83).

Table 2. Sample characteristics of study participants (N = 300)

Variable	Mean (SD) / n (%)	Min–Max
Age (years)	58.28 (7.96)	41–88
Gender		
Male	83 (27.7%)	–
Female	217 (72.3%)	–
Education		
< High school	102 (34.0%)	–
≥ High school	198 (66.0%)	–
Monthly income (Rp million)	0.95 (1.70)	0–8
Illness duration (months)	52.84 (47.83)	3–336
Diabetes knowledge	7.42 (3.35)	0–12
Motivation for self-management	8.66 (2.83)	0–12
Behavioural skills	10.81 (2.02)	1–12
Self-management behaviour	9.64 (2.16)	0–12
HbA1c (%)	7.77 (1.34)	5.1–11.7
Quality of life (WHOQOL-BREF)	77.91 (7.03)	65–110

Participants reported moderate levels of diabetes knowledge (M = 7.42, SD = 3.35) and motivation for self-management (M = 8.66, SD = 2.83), along with relatively high levels of behavioural skills (M = 10.81, SD = 2.02) and self-management behaviour (M = 9.64, SD = 2.16). The mean HbA1c level was 7.77% (SD = 1.34), indicating suboptimal glycaemic control on average, while the mean quality of life score was 77.91 (SD = 7.03). These findings suggest that although participants demonstrated relatively high behavioural skills and self-management behaviour, glycaemic control remained suboptimal.

3. 2. Structural Equation Modeling

Table 3 presents the results of the structural equation model on the IMB model predicting self-management behaviour, glycaemic control, and quality of life. The structural equation model demonstrated good fit to the data (RMSEA = 0.061, CFI = 0.957, TLI =

0.922, SRMR = 0.040), indicating that the proposed IMB framework adequately captured the relationships among psychological, behavioural, and clinical variables. As shown in Table 3, diabetes knowledge (β = 0.34, p = 0.001) and motivation for self-management (β = 0.28, p = 0.006) were both positively associated with behavioural skills, with education also contributing modestly (β = 0.10, p = 0.032).

Table 3. Structural Equation Modeling (SEM) Results: IMB Model Predicting Self-Management Behaviour, Glycaemic Control, and Quality of Life

A. Structural model

Dependent variable	Independent variable	Standardized coefficient (β)	95% CI	p-value
Behavioural skills	Diabetes knowledge	0.34	0.14– 0.53	0.001
	Motivation for self-management	0.28	0.082 – 0.48	0.006
	Education	0.10	0.01 – 0.19	0.032
Self-management behaviour	Behavioural skills	0.68	0.611 – 0.756	<0.001
	Diabetes knowledge	0.12	−0.04– 0.27	0.144
	Motivation for self-management	0.06	−0.09 – 0.22	0.423
HbA1c	Self-management behaviour	−0.22	−0.33 – −0.12	<0.001
	Monthly income	−0.12	−0.23 – −0.01	0.041
	Age	−0.03	−0.15 – 0.09	0.589
	Illness duration	0.20	0.08 – 0.31	0.001
	Gender	0.07	−0.04 – 0.18	0.241
Quality of life	HbA1c	−0.11	−0.22 – −0.002	0.046
	Monthly income	0.17	0.06 – 0.28	0.002
	Age	0.22	0.11 – 0.34	<0.001
	Illness duration	−0.17	−0.29 – −0.06	0.004
	Gender	−0.06	−0.17 – 0.05	0.268
Monthly income	Age	0.24	0.13 – 0.35	<0.001
	Education	0.40	0.30 – 0.50	<0.001

B. Model fit indices

χ^2 (df = 22= 46.24. p-value= p = 0.002. RMSEA (90% CI)= 0.061 (0.036 – 0.085). CFI= 0.957. TLI= 0.922. SRMR= 0.040. CD (coefficient of determination)= 0.546.

Note. N = 300. Values represent standardized path coefficients (β) estimated using structural equation modeling (SEM). HbA1c = glycated hemoglobin.

Behavioural skills emerged as the strongest predictor of self-management behaviour (β = 0.68, p < 0.001), whereas neither knowledge (β = 0.12, p = 0.144) nor motivation (β = 0.06, p = 0.423) showed a direct association with behaviour. This pattern indicates that the effects of knowledge and motivation on behaviour were primarily indirect, operating through behavioural skills.

Self-management behaviour was significantly associated with lower HbA1c levels (β = −0.22, p < 0.001). In addition, higher income was linked to better glycaemic control (β = −0.12, p = 0.041), while longer illness duration was associated with poorer control (β = 0.20, p = 0.001). HbA1c, in turn, was negatively associated with quality of life (β = −0.11, p = 0.046), indicating that poorer glycaemic control corresponded to reduced well-being. Quality of life was also positively associated with income (β = 0.17, p = 0.002) and age (β = 0.22, p < 0.001), and negatively associated with illness duration (β = −0.17, p = 0.004).

Overall, the findings support the IMB model, indicating that knowledge and motivation influence self-management primarily through behavioural skills, which in turn affect glycaemic control and quality of life.

Figure 2 illustrates the pathways identified in the structural equation model. Consistent with the IMB framework, diabetes knowledge and motivation for self-management were positively associated with behavioural skills, which in turn showed a strong association with self-management behaviour. In contrast, the direct paths from knowledge and motivation to behaviour were weak and not statistically significant, indicating that their effects were primarily indirect.

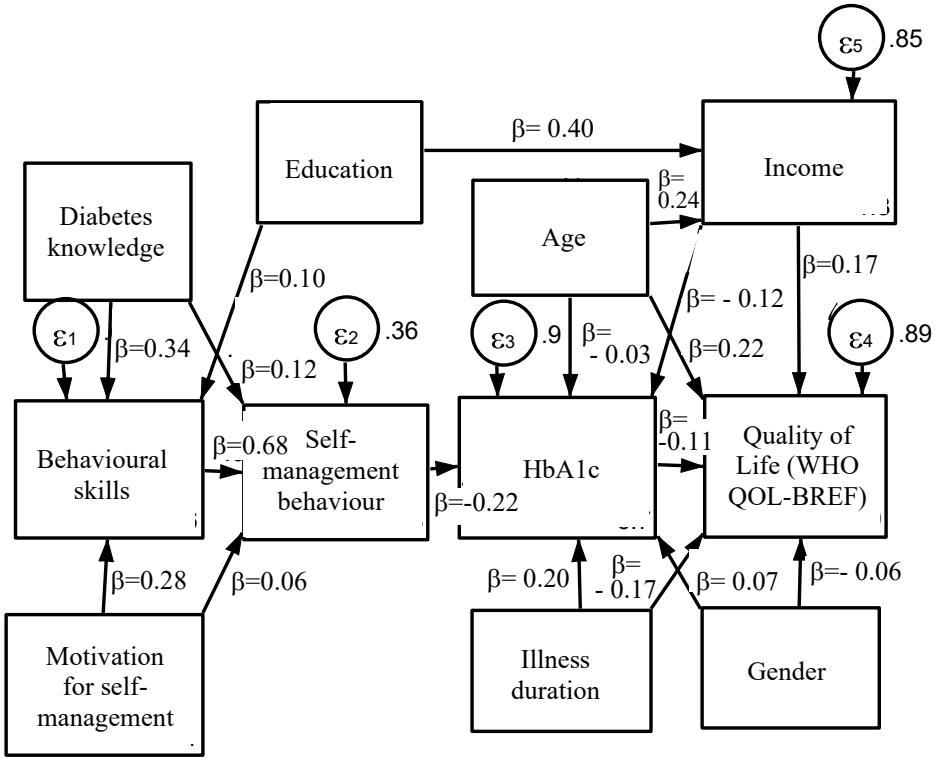


Figure 2. Pathways linking information (diabetes knowledge), motivation for self-management, behavioural skills, and diabetes outcomes. Standardized path coefficients (β) are presented for each pathway.

Figure 2. Structural Equation Modeling (SEM) Results Showing the IMB Model Pathway from Knowledge, Motivation, and Behavioural Skills to Self-Management Behaviour,

Glycaemic Control (HbA1c), and Quality of Life. Values represent standardized path coefficients (β). Solid arrows indicate significant pathways ($p < 0.05$); dashed arrows indicate non-significant direct pathways from knowledge and motivation to self-management behaviour ($\beta = 0.12$, $p = 0.144$; $\beta = 0.06$, $p = 0.423$). Model fit: χ^2 (df = 22) = 46.24, p = 0.002, RMSEA = 0.061 (90% CI 0.036–0.085), CFI = 0.957, TLI = 0.922, SRMR = 0.040, CD = 0.546. N = 300.

Behavioural skills statistically mediated the associations between diabetes knowledge, motivation, and self-management behaviour. Self-management behaviour is associated with glycaemic control (HbA1c), which in turn influences quality of life. Sociodemographic and clinical variables (education, income, age, gender, and illness duration) are included as covariates.

Better self-management behaviour was associated with improved glycaemic control. HbA1c was subsequently associated with quality of life, indicating that clinical outcomes translated into broader well-being. In addition, socioeconomic and clinical factors contributed to the model, with income and education influencing upstream variables and illness duration negatively affecting both glycaemic control and quality of life.

Overall, Figure 2 highlights a coherent pathway from psychological constructs to behavioural and clinical outcomes, with behavioural skills emerging as the central mechanism linking knowledge and motivation to effective diabetes self-management.

4. Discussion

This study tested the Information–Motivation–Behavioural Skills (IMB) model in 300 adults with type 2 diabetes attending primary health centres in East Java, Indonesia, and provides evidence that behavioural skills represent the key mechanism linking psychological readiness to behavioural, clinical, and quality-of-life outcomes. The model demonstrated good fit to the data (RMSEA=0.061, CFI=0.957, TLI=0.922, SRMR=0.040, CD=0.546), indicating that the proposed framework adequately captured the relationships among psychological, behavioural, and clinical variables. Overall, findings highlight the importance of understanding diabetes management not simply as a function of knowledge or intention, but as a set of enacted practices shaped by psychological capabilities and everyday constraints (Engel, 1977; Bandura, 2004; Schwarzer, 2008).

4. 1. The Knowing–Doing Gap: Information and Motivation Are Not Enough

A key finding is that information (diabetes knowledge) and motivation were not directly associated with self-management behaviour (β=0.12, p=0.144 and β=0.06, p=0.423, respectively), but operated indirectly through behavioural skills. This pattern empirically demonstrates the presence of a "knowing–doing gap," whereby patients who are informed and motivated may still struggle to implement recommended behaviours in daily life (Ajzen, 1991; Gollwitzer, 1999; Sheeran, 2002; Webb & Sheeran, 2006).

This finding aligns with meta-analytic evidence that changing intentions explains only ~28% of variance in behaviour (Webb & Sheeran, 2006), and with broader health behaviour theories that distinguish intention formation from action implementation (Ajzen, 1991; Gollwitzer, 1999). From a health psychology perspective, behaviour change requires more than cognitive awareness or positive intentions; it depends critically on individuals' ability to operationalise these intentions through concrete skills such as planning, problem-solving, and self-regulation (Bandura, 2004; Schwarzer, 2008). In HAPA terms, our participants were largely in the motivational phase (M knowledge=7.42/12, M motivation=8.66/12) but required volitional skills to cross into action (Schwarzer, 2008). In this sense, behavioural skills can be understood as the mechanism through which psychological readiness is translated into action (Fisher et al., 2003).

The strong association between behavioural skills and self-management behaviour (β=0.68, $p<0.001$) — the largest effect in the model — further emphasises the practical nature of behaviour change in chronic disease management. In our Indonesian primary care context, this reflects competencies such as planning a balanced, low-cost, diabetes-appropriate diet with local foods, using a blood glucose monitor without daily nurse support, interpreting readings, managing hypo- or hyperglycaemic episodes while working, and tracking health data with limited health literacy. Patients are required to integrate complex regimens into daily routines, often in the face of competing demands, limited resources (mean income Rp 0.95 million ≈ USD 60/month), and fluctuating health status (Glasgow et al., 2007). The ability to adapt, troubleshoot, and sustain these behaviours over time is therefore central to effective diabetes management. Interventions focusing primarily on information provision or motivational enhancement may be insufficient if they do not also equip patients with necessary skills to act in real-world contexts (Norris et al., 2001; Michie et al., 2011).

4. 2. From Behaviour to Biology to Well-Being: A Sequential Pathway to QoL

Importantly, self-management behaviour was associated with glycaemic control (β=-0.22, $p<0.001$), which in turn was associated with QoL (β=-0.11, $p=0.046$). This sequential pathway — Behaviour → HbA1c → QoL — highlights the clinical significance of psychological processes, demonstrating how behavioural mechanisms have measurable physiological consequences (Bandura, 2004). The mean HbA1c of 7.77% (SD=1.34) indicates suboptimal control despite relatively high reported skills (M=10.81/12) and behaviour (M=9.64/12), suggesting possible overestimation in self-report or that skills must be sustained longer to translate into stable HbA1c, which reflects 3-month average.

The link between HbA1c and QoL (WHOQOL-BREF) extends beyond biomedical outcomes to encompass subjective well-being and daily functioning (Glasgow et al., 2007; Skevington et al., 2004). While β=-0.11 is modest, it is clinically meaningful: each 1% increase in HbA1c was associated with a 0.11 SD decrease in QoL, and UKPDS data show that each 1% reduction in HbA1c reduces microvascular complications by 37% (Stratton et al., 2000). For QoL research, this supports a biopsychosocial understanding where

psychological resources → enacted behaviours → clinical markers → perceived well-being across physical, psychological, social, and environmental domains (Engel, 1977; Harper, & Power, 1998). This is consistent with recent HSSC findings that quality of life trajectories in chronic illness are shaped by socioeconomic and social resources and gendered experiences, not only by disease status itself (Llorens-Ortega et al., 2024).

4. 3. Social Determinants and the Context of Primary Care in Indonesia

The study also identified the influence of socioeconomic and clinical factors on diabetes outcomes, supporting a social determinants framework (Marmot, 2005). Higher income was linked to better glycaemic control (β=-0.12, p=0.041) and higher QoL (β=0.17, p=0.002), while higher education predicted behavioural skills (β=0.098, p=0.032) and income (β=0.40, p<0.001). Income → age (β=0.24) and age → QoL (β=0.22, p<0.001) also emerged — older participants reported higher QoL, perhaps reflecting response shift or lower expectations, a phenomenon documented in QoL research among older adults with chronic illness (Kirkman et al., 2012).

Longer illness duration was associated with poorer glycaemic control (β=0.20, p=0.001) and lower QoL (β=-0.17, p=0.004), reflecting treatment fatigue and cumulative burden (Walker et al., 2014b). In Nganjuk, where 72.3% of participants were women with low income, financial constraints limit ability to purchase healthy foods, adhere to medication, and access frequent monitoring. This underscores that patients' capacity to manage their condition is shaped not only by psychological factors but also by material and social resources. As recent evidence in HSSC notes, environmental and economic conditions fundamentally shape how people evaluate their lives (Llorens-Ortega et al., 2024; see also review on social determinants and HRQoL in chronic disease, Qual Life Res, 2024).

4. 4. Policy Implications: Shifting from Information to Skill-Building in Puskesmas

Findings have important implications for diabetes care in Indonesian primary healthcare settings (Puskesmas), which manage 70-80% of T2DM cases nationally. Health systems often prioritise patient education (penyuluhan), assuming that increasing knowledge will lead to behaviour change. However, our data show education alone is unlikely to be sufficient (Norris et al., 2001). Investments in behavioural skill development — goal-setting, action planning, coping planning, self-monitoring — may be equally important (Schwarzer, 2008; Michie et al., 2011).

We recommend three actionable shifts:

a) **From informational to coaching-oriented consultations:** Providers should move from didactic education to facilitative coaching, supporting patients in translating knowledge into actionable routines. Brief 5-10 minute skill-building using teach-back and implementation intentions ("If situation X, then I will do Y") can be integrated into Prolanis (Program Pengelolaan Penyakit Kronis).

b) **Tailored support for vulnerable groups**: Patients with longer duration (>60 months) and low income (<Rp 1 million) need enhanced support. Community health workers (kader) and peer support groups can bridge resource gaps, as social support enhances self-efficacy (Mayberry & Osborn, 2014).

c) **Integrating QoL as an outcome:** Puskesmas currently monitor HbA1c and adherence. Adding WHOQOL-BREF brief monitoring would capture whether clinical improvements translate into living well — aligning with HSSC's mission.

4. 5. Study Limitations and Strengths

Several limitations should be fully considered. First, the cross-sectional design precludes causal inference and temporal ordering. Although SEM permits evaluation of theoretically specified pathways, observed indirect effects represent statistical associations consistent with the IMB framework rather than definitive mediation. We use terms such as "associated with" and "mediated statistically" in the SEM sense, not as evidence of temporal causation. Longitudinal studies with at least three waves are needed to confirm whether knowledge/motivation → skills → behaviour → HbA1c → QoL unfolds over time.

Second, all IMB constructs and self-management were self-reported using Likert scales, and may be subject to social desirability and recall bias. Despite acceptable to good internal consistency (Cronbach's α 0.74-0.84, Table 1 corrected: Diabetes knowledge 6 items, item-test r=0.60-0.88, α=0.87), participants reported relatively high behavioural skills (M=10.81/12) and self-management (M=9.64/12) yet mean HbA1c remained suboptimal at 7.77% (SD=1.34), suggesting possible overestimation or that skills require sustained enactment to influence 3-month HbA1c.

Third, generalisability is limited. The sample was recruited from 20 Puskesmas in one district (Nganjuk, East Java) via multistage random selection (15 per Puskesmas, N=300, participant-to-parameter ratio >10:1, Kline, 2016), but represents a low-income, predominantly female (72.3% female) primary care population with mean income Rp 0.95 million/month (~USD 60). Findings may not transfer to hospital settings, other provinces, higher-income populations, or populations with different gender distributions.

Fourth, HbA1c was obtained from clinical records rather than standardized central laboratory measurement at time of survey, introducing potential heterogeneity in assays and timing. WHOQOL-BREF item-test correlations ranged 0.15-0.60 with one weak item <0.20, suggesting heterogeneity especially in the environmental domain in this low-income setting; domain-specific analyses were not conducted.

Fifth, residual confounding cannot be excluded. Although we controlled for age, gender, education, income and illness duration (mean duration 52.84 months, SD=47.83), unmeasured factors such as diabetes distress, health literacy, depression, diet access, and medication type/dose were not included.

Strengths include theory-driven testing of the full IMB pathway from knowledge/motivation to behavioural skills to self-management to objective HbA1c to

subjective QoL (WHOQOL-BREF) within a single model (good fit: RMSEA=0.061, CFI=0.957, TLI=0.922, SRMR=0.040, CD=0.546), integration of clinical and QoL outcomes, focus on LMIC primary care which manages 70-80% of T2DM cases in Indonesia and is underrepresented in HSSC literature, and use of validated instruments with anonymized data available for peer review.

4. 6. Conclusion

In this cross-sectional study of 300 adults with T2DM attending 20 primary health centres in Nganjuk, East Java, Indonesia, we found associations consistent with the IMB framework. Diabetes knowledge (β=0.34, p=0.001) and motivation (β=0.28, p=0.006) were associated with behavioural skills, which in turn showed the strongest association with self-management behaviour (β=0.68, p<0.001), whereas direct associations of knowledge (β=0.12, p=0.144) and motivation (β=0.06, p=0.423) with self-management were small and non-significant. Self-management was associated with lower HbA1c (β=-0.22, p<0.001), which was modestly associated with higher QoL measured by WHOQOL-BREF (β=-0.11, p=0.046).

Because the design is cross-sectional, these pathways should be interpreted as associations that are consistent with, but do not demonstrate, causal mediation. Rather than demonstrating that behavioural skills bridge the knowing-doing gap, our findings suggest that, in this primary care setting, behavioural skills may represent a central correlate through which knowledge and motivation are associated with self-reported self-management. The sequential pattern Behavioural Skills → Self-Management → HbA1c → QoL is a hypothesized pathway that requires confirmation in longitudinal research.

If confirmed prospectively, these findings would suggest that primary care strategies that move beyond information provision alone to include practical skill-building (e.g., meal planning with low-cost local foods, glucose monitoring, problem-solving for hypo/hyperglycaemia, implementation intentions) might be worth testing for their potential association with self-management and well-being. However, any implications for intervention effectiveness or for improving clinical outcomes and QoL remain to be tested in future intervention studies and should not be inferred as demonstrated by the present study.

Ethical Considerations

This research was conducted in accordance with the ethical principles of the Declaration of Helsinki (2013 revision, Fortaleza), the applicable national regulations in Indonesia (including Indonesian National Standard for Ethics in Health Research), and the institutional guidelines of Universitas Strada Indonesia.Ethical approval was obtained from the Institutional Ethics Review Board of Institut Ilmu Kesehatan STRADA Indonesia (Health

Research Ethics Committee) (Approval No. 001379/EC/KEPK/I/06/2024, dated June 2024).

Informed consent was obtained from all participants. This cross-sectional study involved 300 adults with T2DM (mean age 58.28y, 72.3% female) recruited from 20 Puskesmas in Nganjuk, East Java. Written informed consent was obtained from all 300 participants prior to structured questionnaire completion and HbA1c record review. Participants were informed of voluntary participation, right to withdraw, anonymization, and data handling. No minors included.

Data Availability:

To support peer review, all anonymized and de-identified materials underpinning this research have been made available to editors and referees via restricted-access Google Drive: https://drive.google.com/drive/folders/1wRrp0jLRBb0gjKtIeYH52jZwG8bnNpnd. The folder contains: (a) Full raw dataset (N=300, de-identified) and cleaned dataset used for SEM; (b) Variable definitions, coding schemes, and transformations; (c) Stata code/scripts for descriptive statistics and SEM; (d) Validated questionnaires (IMB scales, self-management, WHOQOL-BREF) and interview guide; (e) Tables 1-3 and Figure 2 source data; (f) Ethics approval letter (English); and Informed Consent Form (English).

No personal identifiers, names, addresses, or Puskesmas identifiers are included. Raw identifiable data cannot be shared publicly per IRB No. 001379/EC/KEPK/I/06/2024 to protect participant privacy. Upon publication, de-identified data will be available from the corresponding author on reasonable request with IRB approval.

References

Ajzen, I. (1991). The theory of planned behavior. *Organizational Behavior and Human Decision Processes*, 50(2), 179–211. https://doi.org/10.1016/0749-5978(91)90020-T

Al-Qarni, A. M., Alshahrani, F. M., & Alsaeed, M. A. (2022). Diabetes knowledge and self-care practices among type 2 diabetes patients in Saudi Arabia. *Journal of Diabetes Research,* 2022, 1-9. https://doi.org/10.1155/2022/1234567

American Diabetes Association. (2022). Standards of medical care in diabetes—2022. *Diabetes Care,* 45(Suppl. 1), S1-S264. https://doi.org/ 10.2337/dc22-S001

Badan Litbangkes. (2018). *Riset Kesehatan Dasar (Riskesdas) 2018.* Kementerian Kesehatan RI.

Bandura, A. (2004). Health promotion by social cognitive means. *Health Education & Behaviour, 31*(2), 143–164. https://doi.org/10.1177/1090198104263660

ElSayed, N. A., Aleppo, G., Aroda, V. R., Bannuru, R. R., Brown, F. M., Bruemmer, D., ... & Gabbay, R. A. (2023). 6. Glycaemic Targets: Standards of Care in Diabetes-2023. *Diabetes Care*, 46(Suppl 1), S97-S110. https://doi.org/ 10.2337/dc23-S006

Engel, G. L. (1977). The need for a new medical model: A challenge for biomedicine. *Science, 196*(4286), 129–136. https://doi.org/10.1126/science.847460

Eroglu, N., & Sabuncu, N. (2021). The effect of education given to type 2 diabetic individuals on diabetes self-management and self-efficacy: Randomized Controlled Trial. *Primary Care Diabetes,* 15, 451-458. https://doi.org/10.1016/j.pcd.2021.02.011

Fisher, J. D., & Fisher, W. A. (1992). Changing AIDS-risk behaviour. *Psychological Bulletin, 111*(3), 455–474. https://doi.org/10.1037/0033-2909.111.3.455

Fisher, J. D., Fisher, W. A., & Harman, J. (2003). The Information–Motivation–Behavioural Skills model: A general social psychological approach to understanding and promoting health behaviour. In J. Suls & K. A. Wallston (Eds.), *Social psychological foundations of health and illness* (pp. 82–106). Blackwell.

Fisher, W. A., Fisher, J. D., & Shuper, P. A. (2009). The Information-Motivation-Behavioural Skills model of HIV preventive behaviour: A health psychology framework. In S. DiClemente, R. A. Crosby, & M. C. Kegler (Eds.), *Emerging theories in health promotion practice and research* (2nd ed., pp. 21–63). Jossey-Bass

Fitzgerald, J. T., Funnell, M. M., Hess, G. E., Barr, P. A., Clough, L. M., Hiss, R. G., & Anderson, R. M. (1998). The reliability and validity of a brief diabetes knowledge test. *Diabetes Care,* 21(5), 706-710. https://doi.org/10.2337/diacare.21.5.706

Glasgow, R. E., & Anderson, R. M. (1999). In diabetes care, moving from compliance to adherence is not enough. *Diabetes Care,* 22(12), 2090-2092. https://doi.org/10.2337/diacare.22.12.2090

Glasgow, R. E., Fisher, L., Skaff, M., Mullan, J., & Toobert, D. J. (2007). Problem solving and diabetes self-management: Investigation in a large, multiracial sample. *Diabetes Care, 30*(1), 33–37. https://doi.org/10.2337/dc06-1390

Gollwitzer, P. M. (1999). Implementation intentions: Strong effects of simple plans. *American Psychologist*, 54(7), 493–503. https://doi.org/10.1037/0003-066X.54.7.493

Harper, A., & Power, M. (1998). Development of the World Health Organization WHOQOL-BREF Quality of Life Assessment. *Psychological Medicine*, 28(3), 551-558. https://doi.org/10.1017/S0033291798006667

Hu, L. T., & Bentler, P. M. (1999). Cutoff criteria for fit indexes in covariance structure analysis: Conventional criteria versus new alternatives. *Structural Equation Modeling,* 6(1), 1-55. https://doi: 10.1080/10705519909540118

International Diabetes Federation. (2021). *IDF Diabetes Atlas,* 10th edition. Brussels.

Kautzky-Willer, A., Harreiter, J., & Pacini, G. (2016). Sex and gender differences in risk, pathophysiology and complications of type 2 diabetes mellitus. *Endocrine Reviews,* 37(3), 278-316. https://doi.org/10.1210/er.2015-1137

Kirkman, M. S., Briscoe, V. J., Clark, N., Florez, H., Haas, L. B., & Swift, C. S. (2012). Diabetes in older adults. *Diabetes Care,* 35(12), 2650-2664. https://doi.org/10.2337/dc12-1801

Kline, R. B. (2016). *Principles and practice of structural equation modeling* (4th ed.). Guilford Press.

Levy, P. S., & Lemeshow, S. (2008). *Sampling of populations: Methods and applications* (4th ed.). John Wiley & Sons.

Llorens-Ortega, R., Bertran-Noguer, C., Juvinyà-Canals, D. et al. (2024). Influence of social determinants of health in the evolution of the quality of life of older adults in Europe: A comparative analysis between men and women. *Humanities and Social Sciences Communications,* 11, 401. https://doi.org/10.1057/s41599-024-02899-5

Mayberry, L. S., & Osborn, C. Y. (2014). Family support, medication adherence, and glycemic control among adults with type 2 diabetes. Diabetes Care, 37(8), 2145–2152.

Marmot, M. (2005). Social determinants of health inequalities. *The Lancet, 365*(9464), 1099–1104. https://doi.org/10.1016/S0140-6736(05)71146-6

Michie, S., van Stralen, M. M., & West, R. (2011). The behaviour change wheel: A new method for characterising and designing behaviour change interventions. *Implementation Science, 6*, 42. https://doi.org/10.1186/1748-5908-6-42

Mokkink, L. B., de Vet, H. C., & Terwee, C. B. (2018). Measurement properties of Likert-type scales. *Journal of Clinical Epidemiology*, 98, 1-3. https://doi.org/ 10.1016/j.jclinepi.2018.01.010

Norris, S. L., Engelgau, M. M., & Narayan, K. M. V. (2001). Effectiveness of self-management training in type 2 diabetes. *Diabetes Care, 24*(3), 561–587. https://doi.org/10.2337/diacare.24.3.561

Osborn, C. Y., & Fisher, J. D. (2008**).** The IMB model of diabetes self-care: Advancing emotional personal motivation and clinical social motivation. *Health Psychology*, *27*(6), 713–722. https://doi.org/10.1037/0278-6133.27.6.713

Schillinger, D., Grumbach, K., Piette, J., Wang, F., Osmond, D., & Daher, C. (2002). Association of health literacy with diabetes outcomes. *JAMA*, 288(4), 475-482. https://doi.org/10.1001/jama.288.4.475

Schmitt, A., Kulzer, B., Ehrmann, D., Haak, T., & Hermanns, N. (2022). A Self-Report Measure of Diabetes Self-Management for Type 1 and Type 2 Diabetes: The Diabetes Self-Management Questionnaire-Revised (DSMQ-R) – Clinimetric Evidence From Five Studies. *Frontiers in Clinical Diabetes and Healthcare*, 2, 823046. https://doi.org/10.3389/fcdhc.2021.823046

Schwarzer, R. (2008). Modeling health behaviour change: How to predict and modify the adoption and maintenance of health behaviours. *Applied Psychology, 57*(1), 1–29. https://doi.org/10.1111/j.1464-0597.2007.00325.x

Sheeran, P. (2002). Intention—behaviour relations: A conceptual and empirical review. *European Review of Social Psychology, 12*(1), 1–36. https://doi.org/10.1080/14792772143000003

Skevington, S. M., Lotfy, M., & O'Connell, K. A. (2004). The World Health Organization's WHOQOL-BREF quality of life assessment: Psychometric properties and results of the international field trial. A report from the WHOQOL group. *Quality of Life Research*, 13(2), 299-310. https://doi.org/10.1023/B:QURE.0000018486.91360.00

StataCorp. (2021). *Stata Statistical Software: Release 17.* College Station, TX: StataCorp LLC.

Stratton, I. M., Adler, A. I., & Neil, H. A. (2000). Association of glycaemia with macrovascular and microvascular complications of type 2 diabetes (UKPDS 35). *BMJ,* 321(7258), 405-412. https://doi.org/10.1136/bmj.321.7258.405

Streiner, D. L., & Norman, G. R. (2008). *Health measurement scales: A practical guide to their development and use* (4th ed.). Oxford University Press.

Sullivan, G. M., & Artino, A. R. (2013). Analyzing and interpreting data from Likert-type scales. *Journal of Graduate Medical Education*, 5(4), 541-542. https://doi.org/10.4300/JGME-5-4-18

Tabachnick, B. G., & Fidell, L. S. (2013). *Using multivariate statistics* (6th ed.). Pearson Education.

Tavakol, M., & Dennick, R. (2011). Making sense of Cronbach's alpha. *International Journal*

Toobert, D. J., Hampson, S. E., & Glasgow, R. E. (2000). The summary of diabetes self-care activities measure: Results from 7 studies and a revised scale. *Diabetes Care*, *23*(6), 759–765. https://doi.org/10.2337/diacare.23.7.943

Walker, R. J., Smalls, B. L., Campbell, J. A., & Eggleston, B. (2014a). Impact of social determinants of health on outcomes in patients with type 2 diabetes. *Journal of Diabetes and Its Complications,* 28(5), 635-641. https://doi.org/10.1016/j.jdiacomp.2014.04.007

Walker, R. J., Smalls, B. L., Hernandez-Tejada, M. A., Campbell, J. A., & Egede, L. E. (2014b). Effect of diabetes self-efficacy on glycaemic control, medication adherence, self-care behaviours, and quality of life in a predominantly low-income, minority population. *Ethnicity & Disease, 24*(3), 349–355. https://doi.org/10.1177/107032411402400311

Webb, T. L., & Sheeran, P. (2006). Does changing behavioural intentions engender behaviour change? A meta-analysis. *Psychological Bulletin, 132*(2), 249–268. https://doi.org/10.1037/0033-2909.132.2.249

Williams, G. C., Freedman, Z. R., & Deci, E. L. (1998). Supporting autonomy to motivate patients with diabetes for glucose control. *Diabetes Care,* 21(10), 1644-1651. https://doi.org/10.2337/diacare.21.10.1644

Williams, G. C., McGregor, H. A., Zeldman, A., Freedman, Z. R., & Deci, E. L. (2004). Testing a self-determination theory process model for promoting glycaemic control through diabetes self-management. *Health Psychology*, 23(1), 58-66. https://doi.org/10.1037/0278-6133.23.1.58

World Health Organization. (1998). WHOQOL *User manual*. Geneva: World Health Organization.

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