



Published by
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Exposure to Transtheoretical Model-based exercise associated with higher physical activity levels among type 2 diabetes mellitus patients at Dr. Oen Hospital, Surakarta

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ABSTRACT

Background and purpose: Many people with type 2 diabetes mellitus (T2DM) do not do physical activity and those who have started doing physical activity often stop within 3-6 months. The main difficulty faced by individuals with T2DM is psychological, primarily due to low self-confidence to engage in regular physical activity. It is necessary to provide IEC or physical activity recommendations using behavior change strategies to encourage compliance of individuals with T2DM in carrying out physical activity, one of which is using the transtheoretical model (TTM). This research aims to find the association between giving physical activity recommendations based on TTM and the level of physical activity in individuals suffering from T2DM.

Methods: This research is a cross sectional analytic carried out at Dr. Oen Kandang Sapi Hospital Surakarta in February 2024. This research involved 91 respondents selected through consecutive sampling. Data collection was carried out using questionnaires. The available data was analyzed by univariate analysis and bivariate analysis using the Chi-square test.

Results: Most of the physical activity levels of T2DM patients were low (58.2%) and the majority of physical activity behavior change stages were in the preparation stage (51.6%). Meanwhile, 67% of T2DM patients did not carry out physical activity according to recommendations and as many as 71.4% did not receive physical activity recommendations based on TTM. The results of the Chi-square test between physical activity recommendations based on TTM and physical activity levels obtained p value= 0.015.

Conclusion: There is a significant relationship between the provision of physical activity recommendations based on TTM and the physical activity level of T2DM patients at Dr. Oen Kandang Sapi Hospital Surakarta.

Keywords: *Physical activity, T2DM, physical activity recommendations, Transtheoretical Model.*

INTRODUCTION

Diabetes is a chronic disease characterized by elevated blood sugar levels and has become one of the fastest growing global health emergencies in the 21st In 2021, Indonesia ranked fifth globally for the highest number of adults (aged 20–79) living with diabetes, with 19.5 million cases—a figure projected to reach 28.6 million by 2045.¹ Type 2 diabetes mellitus (T2DM) accounts for more than 90% of all diabetes cases worldwide and the number of individuals with T2DM is predicted to reach 7,079 per 100,000 people, reflecting a continuous increase worldwide by 2030.²

T2DM management requires medical supervision and lifestyle changes for optimal glycemic control. Physical activity is one component of the four pillars of T2DM management. Because physical inactivity is a major risk factor for T2DM, incorporating regular exercise is crucial in its treatment strategy.³ According to guidelines from PERKENI⁴, individuals with T2DM are primarily advised to do moderate intensity aerobic for 30–45 minutes per session, accumulating at least 150 minutes per week. This should be performed 3–5 days per week, with no more than two consecutive days of inactivity.

Physical activity provides physiological and psychological benefits for individuals with T2DM such as lowering HbA1c, reducing cardiovascular risk factors, and improving quality of life.⁵ Furthermore, physical activity increases insulin sensitivity, strengthens skeletal muscles, and expands the cross-sectional area (particularly in the quadriceps) which will increase the number of insulin receptors.⁶

Although physical activity has many benefits, many individuals with T2DM struggle to initiate or sustain regular physical activity. An estimated 37 – 60% of patients with T2DM are physically inactive, and among those who do begin exercising, a significant portion discontinue within 3–6 months. A low level of self-confidence (self-efficacy) in their ability to exercise represents the primary barrier to maintaining a regular physical activity routine.⁷

To address these challenges, incorporating psychological approaches and behavior change strategies into physical activity recommendations or Information, Education, and Communication (IEC) is essential for improving adherence among individuals with T2DM. Among available models, the Transtheoretical Model (TTM) is widely regarded as one of the most comprehensive and integrated frameworks, as it incorporates key concepts from other theories, such as the Health Belief Model, Theory of Reasoned Action, and Social Cognitive Theory.⁸

TTM is a model that describes how individuals can change problematic behavior or obtain positive behavior with its main construct, namely stages of change.⁹ TTM is widely adopted for physical activity behavior change interventions, especially in the long term because TTM emphasize on identifying individual readiness to change and can determine physical activity strategies that are appropriate for each individual's stage of change.¹⁰ TTM has four components, namely stages of change, process of change, decisional balance, and self-efficacy.¹¹

Research exploring the relationship between TTM-based physical activity recommendations (or IEC) and physical activity levels among patients with T2DM remains limited in Indonesia. Therefore, this study aims to identify the association of IEC or physical activity recommendations based on TTM to the physical activity

level of T2DM patients, especially at Dr. Oen Kandang Sapi Hospital Surakarta.

METHOD

This was an analytical cross-sectional study with quantitative methods which was held in February 2024 at the Internal Medicine Clinic at Dr. Oen Kandang Sapi Hospital Surakarta. The study population consists of T2DM patients receiving treatment at the Internal Medicine Clinic of Dr. Oen Kandang Sapi Hospital Surakarta. Inclusion criteria were T2DM patients who had been undergoing treatment at the hospital for at least six months and provided informed consent to participate. The exclusion criteria were patients who are unable to perform physical activities due to disability and/or other illnesses. A total of 91 T2DM patients who met the inclusion and exclusion criteria and were selected using consecutive sampling.

Data were collected using validated questionnaires: the International Physical Activity Questionnaire (IPAQ) to measure physical activity levels and the Stages of Exercise Behavior Change Questionnaire to assess the stages of change in physical activity behavior. An additional questionnaire assessed physical activity frequency, intensity, type, and duration to determine patient adherence to recommendations. T2DM patients are categorized as adhering to the recommendations if they meet the physical activity guidelines for T2DM patients based on the PERKENI⁴ recommendations, which includes a frequency of 3-5 days per week, a duration of at least 150 minutes per week, and moderate-intensity physical activity, as calculated from the IPAQ data.

Additionally, five open-ended questions were administered to evaluate whether the physical activity recommendations (or IEC) provided by physicians were based on the TTM. Adapted from TTM-based consultation protocols modified from previous studies by Hasler *et al.*¹¹ and Siregar, Harefa and Hasibuan¹² the questions covered: (1) physical activity recommendations given, (2) perceived benefits of exercise, (3) current physical activity habits, (4) perceived barriers, and (5) motivations or solutions provided. Recommendations were classified as TTM-based if they incorporated all five discussion topics. Finally, demographic and clinical data (including age, sex, and T2DM duration) were also recorded.

Data was analyzed with SPSS ver. 29 that include univariate analysis, and bivariate analysis was carried out to identify the association between TTM-based physical activity recommendation and two outcome variables: physical activity levels and adherence to physical activity recommendations.

This research has obtained ethical clearance issued by the Research Ethics Commission of Faculty of Medicine, Udayana University with number 0187/UN14.2.2.VII.14/LT/2024.

RESULT

The mean age of T2DM patients was 58.48 years with the youngest respondent is 29 years old and the oldest respondent is 85 years old. The average T2DM duration was 7.30 years and was dominated by female (54.9%). The majority of T2DM patients had low physical activity (58.2%), did not adhere do physical activity recommendations (67.0%), and were in the preparation stage (51.6%). Furthermore, only a small proportion of T2DM patients received physical activity recommendations based on TTM (28.6%) (Table 1).

Table 2 shows that the physical activity level has a significant association with experience of receiving

physical recommendation on TTM among all patients and patients with duration of diabetes <2 years, while among those with duration ≥ 2 years there was no significant association. Among all patients, 57.7% of patients who received physical activity recommendations based on TTM and 67.7% who did not receive physical activity recommendations shows low physical activity levels.

Table 2 also shows that among 23 patients with T2DM with a disease duration of <2 years, 71.4% patients who received recommendations based on TTM had a moderate level of physical activity, while 68.8% of those whom did not receive the recommendations shows low level of physical activity and this was statistically significant. Meanwhile, among the 68 T2DM with disease duration of ≥ 2 years who received exercise recommendation, 52.6% showed a moderate level of physical activity while 67.3% of those whom did not receive TTM-based recommendations had a low level of physical activity but not statistically significant different.

Table 1. Socio-demographic, clinical, and physical activity characteristics of patients with T2DM

Variables	f (%)
Age (year)	
Mean $\pm$ SD	58.5 $\pm$ 10.3
Min-Max	29 - 85
Duration of suffering T2DM (year)	
Mean $\pm$ SD	7.3 $\pm$ 6.9
Min-Max	0.5 - 32
Sex	
Male	41 (45.1)
Female	50 (54.9)
Physical activity level	
Low	53 (58.2)
Moderate	34 (37.4)
High	4 (4.4)
Compliance with physical activity recommendations	
Compliant	30 (33.0)
Not compliant	61 (67.0)
Stages of exercise behavior change	
Precontemplation	9 (9.9)
Contemplation	0 (0.0)
Preparation	47 (51.6)
Action	8 (8.8)
Maintenance	27 (29.7)
Physical activity recommendation based on TTM	
Yes	26 (28.6)
No	65 (71.4)

Table 2. Association between physical activity level and recommendations based on TTM amongT2DM Patients

Physical activity recommendations based on TTM	Physical activity level (f (%))			p
	Low	Moderate	High	
All patients				
Yes	9 (34.6)	15 (57.7)	2 (7.7)	0.015
No	44 (67.7)	19 (29.2)	2 (3.1)	
Duration of DM <2 years				
Yes	1 (14.3)	5 (71.4)	1 (14.3)	0.032
No	11 (68.8)	5 (31.3)	0 (0.0)	
Duration of DM ≥2 years				
Yes	8 (42.1)	10 (52.6)	1 (5.3)	0.154
No	33 (67.3)	14 (28.6)	2 (4.1)	

Table 3. Compliance to physical activity based on receiving TTM recommendation status among T2DM patients

Physical activity recommendations based on TTM	Compliance to the recommendations (f (%))		PR	95%CI	p
	Compliant	Not compliant			
All patients					
Yes	14 (53.8)	12 (46.2)	2.19	1.37-9.29	0.007
No	16 (24.6)	49 (75.4)			
Duration of diabetes <2 years					
Yes	5 (71.4)	2 (28.6)	2.29	0.96-5.43	0.074
No	5 (31.3)	11 (68.8)			
Duration of diabetes ≥2years					
Yes	9 (47.4)	10 (52.6)	2.11	1.04-4.27	0.043
No	11 (22.4)	38 (77.6)			

DISCUSSION

We observed more than half T2DM patients has low physical activity level. The PERKENI⁴ recommended individuals with T2DM to engage in moderate intensity physical activity. However, the results of this study found only four in ten T2DM patients had moderate levels of physical activity. These findings align with study by Nurayati *et al.*¹³ in which 62.9% people with T2DM engaged in low physical activity. This result is also consistent with T2DM patients tend to adopt a sedentary lifestyle, resulting in low physical activity levels. There are many factors that are suspected to influence physical activity and sedentary lifestyles in T2DM patients, including age, social influences and chronic complications affecting both the physical and psychological health of T2DM patients.¹⁴

The majority of T2DM patients have not adhered to physical activity recommendations, with two third failing to meet the guidelines. This finding is consistent with the study conducted by Ramadhan *et al.*¹⁵ in Saudi Arabia, which reported that only one third of T2DM patients in Saudi Arabia met recommended physical activity levels. The large number of T2DM patients who do not follow the recommended physical activity

guidelines may be driven by diabetic complications and comorbidities, such as foot pain and cardiovascular diseases, which restrict both the ability and motivation of T2DM patients to engage to exercise. Additionally, environmental and educational barriers, including limited access to exercise facilities and a lack of awareness regarding proper exercise technique can also be significant barriers.¹⁶

Above half of T2DM patients in this study were in the preparation stage of physical activity, meaning that the majority of T2DM patients had not yet engaged in regular physical activity, but they had the intention to be regularly active in the next 30 days. Ten percent of the T2DM patients were in the precontemplation stage, meaning they had not engaged in regular physical activity and had no intention of doing so regularly in the next six months. In the action stage, there were almost one in ten T2DM patients had engaged in regular physical activity, but for less than six months, while close to thirty of them were in the maintenance stage, meaning they had been regularly engaging in physical activity for more than six months.

The majority of T2DM patients did not receive physical activity recommendations based on TTM. Generally, internal medicine specialists at Dr. Oen Kandang Sapi Hospital, Surakarta, provided recommendations based on PERKENI guideline, advising patients to engage in at least 150 minutes of aerobic exercise per week, most commonly walking, cycling, aerobics, or swimming.⁵ Physicians also typically explain the health benefits of exercise, such as optimizing glycemic control and weight management. However, recommendations were classified as non-TTM-based for most respondents because most counseling focused solely on physical activity and its benefits. Most physicians did not assess patients' current activity habits which reflect their stage of change, inquire about exercise barriers, or offer actionable solutions for those in the precontemplation and preparation stages. Meanwhile, for the patients received TTM-based counseling, doctors provided appropriate physical activity recommendations, informed them of the benefits of physical activity, inquired about their physical activity habits, discussed the barriers faced in engaging in physical activity, and offered solutions or alternatives to improve their physical activity behaviors.

Individuals with T2DM typically demonstrate greater confidence in pharmacological therapy than physical activity. Therefore, it is necessary to increase motivation and educate patients regarding the benefits of physical activity.¹² Decisional balance, a core construct of TTM, involves weighing the perceived pros and cons of behavior change, encouraging individuals to recognize that the benefits of exercise outweigh its barriers.¹⁷ By highlighting these benefits, physicians effectively addressed the decisional balance construct in these patients. Furthermore, physicians evaluated their baseline physical activity habits, specifically to identify their regularly physical activity. This allows to determine the stage of behavioral change in physical activity, enabling them to provide advice that aligns with the patients' physical activity behaviors. Routine monitoring of physical activity during follow-up visits further reinforced patient motivation and supported sustained physical activity adherence.

Identifying perceived barriers to exercise and providing tailored solutions or alternatives significantly enhances physical activity adherence.¹⁷ Addressing these obstacles (alongside establishing clear goal-setting strategies) is essential for motivating patients with T2DM.¹² Self-efficacy is one component of TTM can be enhanced by establishing realistic exercise goals that build patient confidence.¹⁷ This aspect is reflected in the doctors who have provided physical activity recommendations that are appropriate to the capacity of the T2DM patients.

Consequently, these 26 patients were classified as having received TTM-based recommendations, as their physicians incorporated key behavioral change principles into clinical counseling. However, because primary physicians may encounter time or resource limitations when delivering comprehensive exercise guidance, multidisciplinary collaboration with sports medicine specialists, exercise physiologists, or physical therapists is recommended to optimize physical activity counseling for patients with T2DM.

TTM-based physical activity recommendations were found to be associated with physical activity levels. This finding aligns with study by Jackson, Asimakopoulou and Scammel¹⁸ who reported that TTM-based counseling in outpatient settings significantly increased physical activity levels among patients with T2DM. Similarly, cross-tabulation analysis revealed a statistically significant association between TTM-based recommendations and adherence to physical activity guidelines. This result is consistent with findings by Kirk *et al.*¹⁹ where T2DM patients receiving TTM-based counseling in outpatient clinics experienced significant increases in exercise adherence, with 57% meeting ACSM/CDC guidelines within a 12-month period. Providing recommendations for physical activity using the TTM approach can help in the behavior change process which facilitates changes from the precontemplation stage to the action and maintenance stage, where T2DM patients begin to actively engage in regular physical activity in accordance with existing recommendations or guidelines.

Sub-group analysis based on disease duration of T2DM showed a significant relationship between physical activity recommendations based on TTM and physical activity levels among patients with duration of DM <2 years, while, no significant association was found among patients with a disease duration of ≥ 2 years. This disparity suggests that T2DM patients with a duration of illness <2 years tend to increase their level of physical activity, but it is still not structured according to the established physical activity guidelines for T2DM patients, which include recommended duration, intensity, frequency and type of exercise. On the other hand, T2DM patients with a duration of illness ≥ 2 years have received various education or recommendations related to physical activity and have adapted to long-term management habits, enabling them to adhere to structured guidelines, even though there is no significant increase in physical activity levels.

Meanwhile, a separate analysis was also conducted to determine the difference in the relationship between physical activity recommendations based on TTM and the compliance of physical activity with recommendations for T2DM patients with a duration of illness <2 years and ≥ 2 years. Among patients with a disease duration of <2 years, no statistically significant association was observed between TTM-based recommendations and exercise adherence, while a borderline statistically significant association was found among patients with a disease ≥ 2 years. This difference may stem from psychological adaptation following diagnosis. Recently diagnosed patients often experience difficulty accepting their condition or remain in denial, which can diminish their motivation to adopt lifestyle modifications. Consequently, even when receiving TTM-based counseling, newly diagnosed individuals may lack the emotional readiness or disease awareness necessary to fully adhere to structured physical activity guidelines for optimal glycemic management.

There are several limitations of this research, namely due to limited research time so the study design used is cross sectional and the results obtained can only prove the conditions that occurred at the time of the research. Therefore, the process of change from the stage of change in physical activity behavior, level of physical activity, and suitability of physical activity according to recommendations for T2DM patients that have

occurred or will occur cannot be observed in this study.

CONCLUSION

The study shows that TTM-based physical activity counseling was significantly associated with higher physical activity levels and greater exercise adherence among patients with T2DM at Dr. Oen Kandang Sapi Hospital, Surakarta. Specifically, T2DM patients with a duration of illness of ≥ 2 years were found to be more adherent to physical activity recommendations. Overall, receiving TTM-based counseling positively influenced physical activity behaviors and improved alignment with recommended guidelines. Physicians and healthcare professionals should incorporate behavioral change frameworks, such as the TTM, into routine information, education, and communication (IEC) efforts addressing the psychological dimensions of diabetes management to enhance patient motivation and exercise adherence. Future research should consider to use prospective cohort or longitudinal designs to observe temporal transitions in stages of change, physical activity levels, and long-term guideline adherence over time.

ACKNOWLEDGMENT

The author would like to thank Dr. Oen Kandang Sapi Hospital Surakarta for providing permission and facilitating the data collection process.

AUTHOR CONTRIBUTION

SAI, IPAG, and IMM designed this research. SAI performed data collection and analysis, created the first draft of the manuscript, and edited the manuscript. IPAG, IMM, and LPRS provided input on the research concept, data analysis, and manuscript.

CONFLICT OF INTEREST

None

FUNDING

None

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