

Who Achieved 60 Kilometers in 60 Days of the First Thailand National Steps Challenge? A Cross-Sectional Study of Thai Adults

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Abstract

Thailand had implemented the first national steps challenge in 2020 by Ministry of Public Health with the goal to achieve the distance of walking and running at 60 kilometers in 60 days during 1 February to 31 March 2020. The challenge aimed to increase awareness on physical activity at country-wide level. This study aimed to determine the achievement of 60-km goal of Thailand steps challenge season 1. Website-based data of 203,910 records, of participants who sent distance data, was retrieved and analyzed by descriptive parameters and logistic regression. The achievement of accumulative distance of at least 60 km was analyzed by participants' demographics such as sex, age, body mass index, region, urbanity, and type of participant. The findings revealed that around 46% of participants, who sent distance data, achieved the project goal. Men achieved the goal higher than women. Participants aged 30-59 years, not being obese, living in Bangkok, living in urban areas, and being public health officers, achieved the project goal higher than their counterparts. Being obese, living in rural areas, and being village health volunteers, were less likely to achieve the project goal (adjusted Odds ratio = 0.89, 0.83, 0.43 by multivariate analysis, respectively). The study recommended that the national steps challenge should be continuously implemented by using more strategies to engage participants with different characteristics throughout the project.

Keywords: Thailand national steps challenge, physical activity, health promotion

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ใครบรรลุเป้าหมายระยะทาง 60 กิโลเมตร ใน 60 วัน ของนโยบายส่งเสริมการก้าวเดินครั้งที่ 1 ของประเทศไทย? การศึกษาภาคตัดขวางของประชาชนไทยวัยผู้ใหญ่

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บทคัดย่อ

ประเทศไทย โดยกระทรวงสาธารณสุข ได้ดำเนินนโยบายส่งเสริมการก้าวเดินเป็นครั้งแรกในปี พ.ศ. 2563 ผ่านโครงการก้าวทำใจ โดยมีเป้าหมายที่ระยะทาง 60 กิโลเมตร ใน 60 วัน ตั้งแต่วันที่ 1 กุมภาพันธ์ ถึง 31 มีนาคม พ.ศ. 2563 จุดมุ่งหมายของโครงการคือเพื่อสร้างความตระหนักในการมีกิจกรรมทางกายของประชาชน การศึกษานี้มีจุดประสงค์เพื่อวิเคราะห์การบรรลุเป้าหมายระยะทาง 60 กิโลเมตรของโครงการ โดยวิเคราะห์ข้อมูลผู้สมัครโครงการที่ส่งระยะทางการก้าวเดินจำนวน 203,910 คน จากเว็บไซต์ของโครงการด้วยสถิติเชิงพรรณนาและการวิเคราะห์ถดถอยโลจิสติก โดยมีตัวแปรตามคือการสะสมระยะทางได้เท่ากับหรือมากกว่า 60 กิโลเมตร ตัวแปรต้น คือ ลักษณะประชากรและสังคมของผู้สมัคร ได้แก่ เพศ อายุ ดัชนีมวลกาย ภูมิภาค บริเวณที่อยู่อาศัย และประเภทของผู้สมัคร ผลการศึกษาพบว่า ร้อยละ 46 ของผู้สมัครที่ส่งระยะทางการก้าวเดินบรรลุเป้าหมายระยะทางของโครงการ โดยผู้สมัครเพศชายบรรลุเป้าหมายมากกว่าเพศหญิง ผู้สมัครที่มีอายุ 30-59 ปี ไม่มีภาวะน้ำหนักเกินหรืออ้วน อาศัยในกรุงเทพฯ อาศัยในเขตเมือง และเป็นบุคลากรสาธารณสุข บรรลุเป้าหมายระยะทางมากกว่าผู้สมัครประเภทตรงข้าม ทั้งนี้พบว่าภาวะอ้วน การอาศัยในเขตชนบท การเป็นอาสาสมัครสาธารณสุข ลดโอกาสการบรรลุเป้าหมายระยะทาง (adjusted Odds ratio = 0.86, 0.84, 0.33 จากการวิเคราะห์ถดถอยพหุโลจิสติก ตามลำดับ) การศึกษานี้มีข้อเสนอแนะให้ดำเนินนโยบายส่งเสริมการก้าวเดินอย่างต่อเนื่อง โดยใช้ยุทธศาสตร์การส่งเสริมการมีส่วนร่วมกับโครงการที่หลากหลายสำหรับผู้เข้าร่วมโครงการที่มีความแตกต่างทางลักษณะประชากรและสังคม

คำสำคัญ: นโยบายส่งเสริมการก้าวเดินประเทศไทย, กิจกรรมทางกาย, การส่งเสริมสุขภาพ

Background and Rationale

Physical activity has been described by World Health Organization as any bodily movements produced by skeletal muscles that requires energy expenditure.⁽¹⁾ Insufficient physical activity is the fourth leading risk factor of premature deaths from noncommunicable diseases (NCDs).⁽²⁾ Regular physical activity was proved to create multiple benefits to individual health. It

is associated with reduced risks of heart disease, stroke, breast and colon cancer and diabetes, as well as improvement of mental health and quality of life.⁽³⁾ Thus, increasing physical activity can prevent at least 3.2 million NCD-related mortalities globally per year.⁽²⁾ Statistically, 23% of adults (aged 18 years and above) had insufficient physical activity worldwide in 2010⁽⁴⁾ and 29% of adults had insufficient physical activity in Thailand in 2016.⁽⁵⁾

In response to global burden of physical inactivity, Thailand Physical Activity Strategy 2018-2030⁽⁵⁾ was developed through a rigorous participatory process and endorsed by the Cabinet in August 2018, with the strategic objectives to promote active people, create a conducive environment for active lifestyles, and develop active supporting systems. One of the policies from the Strategy was a national steps challenge policy⁽⁶⁾ with the concept that walking is a central component of physical activity in daily life.⁽⁷⁻⁹⁾ This policy was developed and implemented by the Ministry of Public Health in 2019-2020⁽⁶⁾ under the project name ‘Thailand Steps Challenge Virtual Run Season 1’ with a goal to encourage individuals to collect a distance of walking or running to 60 kilometers (km) in 60 days during 1 February to 31 March 2020, and to promote awareness on physical activity country-wide.⁽¹⁰⁾ An example of the promotional materials was shown in Figure 1.

In the project^(10,11), participants had to register through LINE application by smart phones. Information of name, sex, age, body weight, height, address and identification card number were required. All participants were required to send distance data from built-in smartphone accelerometers to LINE application – as illustrated in Figure 2. The target participants were public health personnel and village health volunteers, but general people were also welcomed to join the project. Project certificates were disseminated on-line to participants who achieved 60 km in 60 days. Special awards, i.e. finisher shirts and medals were given to the first 5,000 men and 5,000



Figure 1. Thailand Steps Challenge Virtual Run Season 1 promotional material

women who achieved the goal and the first 1,000 men and 1,000 women who recorded 100 km. Ten trophies were awarded to ten provinces that had the highest numbers of registered village health volunteers. Distances of all participants could be publicly viewed through the project website. The project was widely campaigned through mass media and Ministry of Public Health regional, provincial and local mechanism.

As this was the first Thailand national steps challenge, the outcomes of the project should be well assessed. This study aimed to determine the achievement of 60-km target of the Thailand steps challenge season 1. Relationships between the goal achievement and participant demographics (sex, age, body mass index (BMI), region, area of residence, and type of participant) were also investigated. We expected that the findings from



Figure 2. Registration and distance reporting processes

this study would improve the upcoming national physical activity policies.

Methodology

Data Sources

Web-based data⁽¹¹⁾, recorded the accumulative distances among the participants of the National Steps Challenge Season 1, was used. The data was uploaded online every 1-3 days. A dataset on 31 March 2020 presented the overall data of the project and 480,115 records were retrieved for the analysis.

We excluded participants who had never sent any distance data during those 60 days of the project to reduce selection bias by including the inactive participants in the analysis as shown in Figure 3. We excluded participants who were not public health officers or village health volunteers as they were not the project target.⁽¹⁰⁾ Participants

aged below 18 years were also excluded according to age requirement for village health volunteer.⁽¹²⁾ Participants aged above 80 years were also excluded to reduce the chance that other family members submitted data on their behalf.⁽¹³⁾ Out of the total 408,115 registered participants in the server, 203,910 participants with complete data were included in this study.

Data Analysis and Variable Management

The primary outcome was the goal achievement reflected by the accumulative distance during 1 February to 31 March 2020. This categorical variable was entered as (i) achieved (distance was 60 km and above), and (ii) not achieved (distance was more than 0 km but less than 60 km).

The relationships between the goal achievement and demographic characteristics of participants were investigated. The key independent variables were sex, age, BMI, region, area of

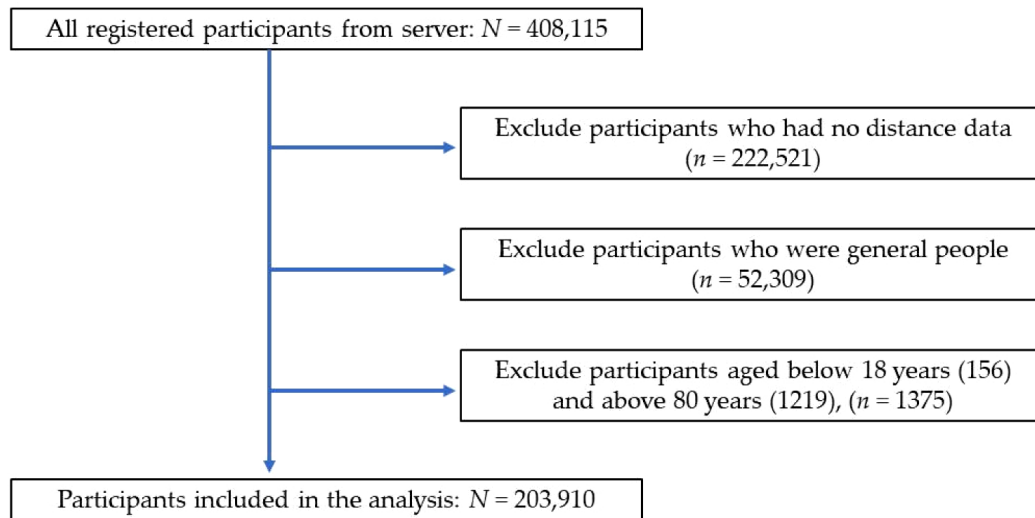


Figure 3. Flowchart of the data selection and analysis

residence, and type of participant. Age was categorized into (i) 18-29 years old, (ii) 30-59 years old, and (iii) 60-80 years old. BMI was grouped into (i) underweight (BMI < 18.5 kg /m²) or normal (BMI ≥ 18.5 and < 23 kg /m²), (ii) overweight (BMI ≥ 23 and < 30 kg /m²), and (iii) obesity (BMI ≥ 30 kg /m²).⁽¹⁴⁾ Region was described as (i) Bangkok, (ii) North, (iii) Northeast, (iv) Central, and (v) South. Area of residence was grouped into (i) urban area (Greater Bangkok and all city districts), and (ii) rural area. Type of participant was categorized into (i) public health officer, and (ii) village health volunteer.

We categorized the distance into ranges; (i) 1-29 km, (ii) 30-59 km, and (iii) 60 km and above, based on distance data submitted throughout participants' engagement in the project. Then, the relationships between distance ranges and demographic characteristics of participants were investigated.

Univariate analysis was performed to study the relationships between the characteristics and

primary outcome variable (achieved 60 km or higher). We performed logistic multivariate regression analysis to assess the effect of primary outcome variable by taking into account the influence of all covariates (sex, age, BMI, region, area of residence, and type of participant). Odds ratio (OR) and 95% confidence interval (95% CI) were calculated to determine the statistical significance.

All analyses were performed by STATA software version 14, StataCorp, College Station, TX, USA (serial number = 10699393).

Ethical Consideration

The dataset used by this study was one of the national physical activity promoting projects conducted by a government agency, called the Department of Health, Ministry of Public Health. As mandated by Public Health Ministerial Regulations 2009⁽¹⁵⁾, the Department of Health was granted with a mission to develop surveillance system to monitor health behavior and health impact

exempting signed consents from respondents. The data source of this study was retrieved from the public website which was unable to track confidential individual data i.e. personal identification numbers. Thus, ethics approval from the Institute for the Development of Human Research Protections is not required. However, the researcher strictly followed ethical standards in research, which all individualized information was strictly kept confidential and not reported in the paper.

Results

Baseline Characteristics

In total, we retrieved 203,910 records. There was a large proportion of female participants (around 84% of total) – as shown in Table 1. The mean age was 45.7 years (standard deviation (SD) = 11.1 years). The median age was 46.8 years (interquartile range (IQR) = 16.3 years). The majority of participants were between 30-59 years old (around

Table 1. Participant characteristics

Characteristics	Overall participants (%)	Male (%)	Female (%)
Age groups			
18-29 years	22,497 (11)	3,619 (11)	18,897 (11)
30-59 years	165,048 (81)	24,546 (77)	140,502 (82)
60-80 years	16,365 (8)	3,666 (12)	12,699 (7)
Mean (SD*)	45.7 (11.1)	46.3 (11.9)	45.6 (10.9)
Median (IQR**)	46.8 (16.3)	47.0 (17.9)	46.7 (16.0)
Body mass index groups			
Underweight or normal	82,963 (41)	11,395 (36)	71,568 (42)
Overweight	41,501 (20)	7,554 (24)	33,947 (20)
Obese	79,446 (39)	12,877 (40)	66,569 (40)
Regions***			
Bangkok	10,000 (5)	1,761 (6)	8,239 (5)
North	22,682 (11)	3,878 (12)	18,804 (11)
Northeast	78,869 (39)	12,386 (39)	66,483 (39)
Central	62,797 (31)	9,813 (31)	52,984 (31)
South	28,959 (14)	3,892 (12)	25,067 (14)
Area of residence			
Urban	48,976 (24)	8,094 (25)	40,882 (24)
Rural	154,934 (76)	23,732 (75)	131,202 (76)
User types			
Public health officers	94,971 (46)	19,498 (61)	75,473 (44)
Village health volunteers	108,939 (54)	12,328 (39)	96,611 (56)
Overall	203,910 (100)	31,826 (100)	172,084 (100)

* SD = standard deviation, ** IQR = interquartile range, *** missing was not included

81% of total). Underweight or normal weight participants accounted for 41%. Around 39% and 31% of participants lived in the Northeast and the Central region, respectively. Seventy-six percent of participants lived in rural areas. The majority of participants were village health volunteers (54%).

Who achieved 60 km in 60 days?

Overall, 46% of participants achieved the goal of the project at 60 km in 60 days – as shown in

Table 2. Men achieved the goal more than women at 49% and 45%, respectively. The participants, who were between 30-59 years old, being underweight or normal BMI, lived in Bangkok, lived in urban areas, and being public health officers, achieved the goal higher than their counterparts (47%, 49%, 63%, 54%, and 57%, respectively).

Participants' profile and distance ranges

The proportions of distance ranges achieved

Table 2. Project goal achievement and participant characteristics

Characteristics	Achieved 60 km (%)*	Not achieved 60 km (%)*
Sex		
Male	15,626 (49)	16,200 (51)
Female	77,755 (45)	94,329 (55)
Age groups		
18-29 years	10,326 (46)	12,171 (54)
30-59 years	77,333 (47)	87,715 (53)
60-80 years	5,722 (35)	10,643 (65)
Body mass index groups		
Underweight or normal	40,366 (49)	42,597 (51)
Overweight	19,063 (46)	22,438 (54)
Obese	33,952 (43)	45,494 (57)
Regions**		
Bangkok	6,256 (63)	3,744 (37)
North	11,175 (49)	11,507 (51)
Northeast	31,508 (40)	47,361 (60)
Central	30,005 (48)	32,792 (52)
South	14,134 (49)	14,825 (51)
Area of residence		
Urban	26,260 (54)	22,716 (46)
Rural	67,121 (43)	87,813 (57)
User types		
Public health officers	54,432 (57)	40,539 (43)
Village health volunteers	38,949 (36)	69,990 (64)
Overall	93,381 (46)	110,529 (54)

* p value <0.001, ** missing was not included

by both sexes were similar – as shown in Figure 4. The participants aged 60-80 years had a higher proportion of 1-29 km range (53%) than other age groups – as shown in Figure 5. The participants who were obese, lived in rural areas, and were village health volunteers had a higher proportion of 1-29 km than their counterparts at 44%, 44%, and 51%, respectively – as shown in Figure 6, 7 and 8.

Univariate and Multivariate Analysis

Based on the univariate logistic regression analysis, findings revealed that being female had

significantly decreased chance to achieve the project goal at 60 km in 60 days (OR = 0.85, 95% CI: 0.83-0.88) - as shown in Table 3. The chance to achieve the project goal was higher with the participants aged 30-59 years (OR = 1.04, 95% CI: 1.01-1.07) and lower with the participants aged 60 years and above (OR = 0.63, 95% CI: 0.61-0.66). According to the multivariate analysis, the participants aged 30-59 years and 60 years and above had significantly increased chance to achieve the project goal (OR = 1.58, 95% CI: 1.53-1.62 and OR = 1.37, 95% CI: 1.31-1.44, respectively). From both univariate and multivariate regression analysis,

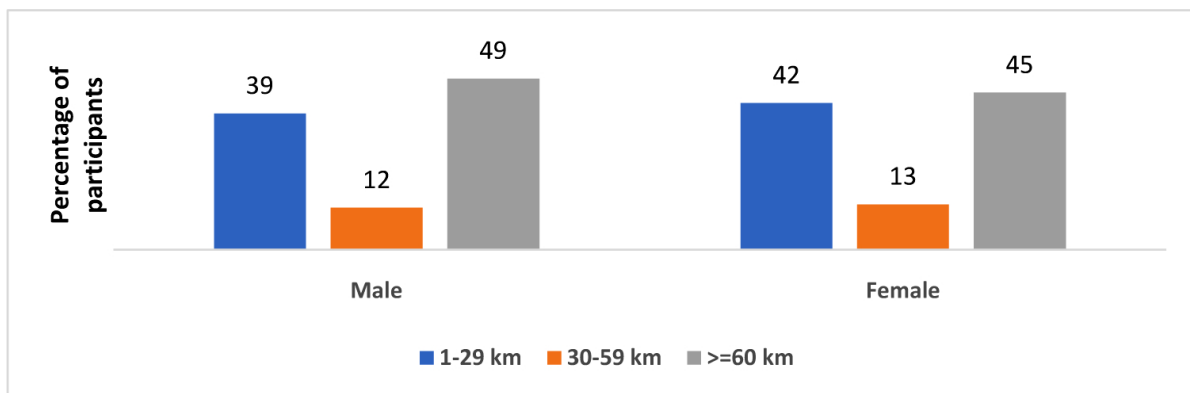


Figure 4. Distance ranges by gender

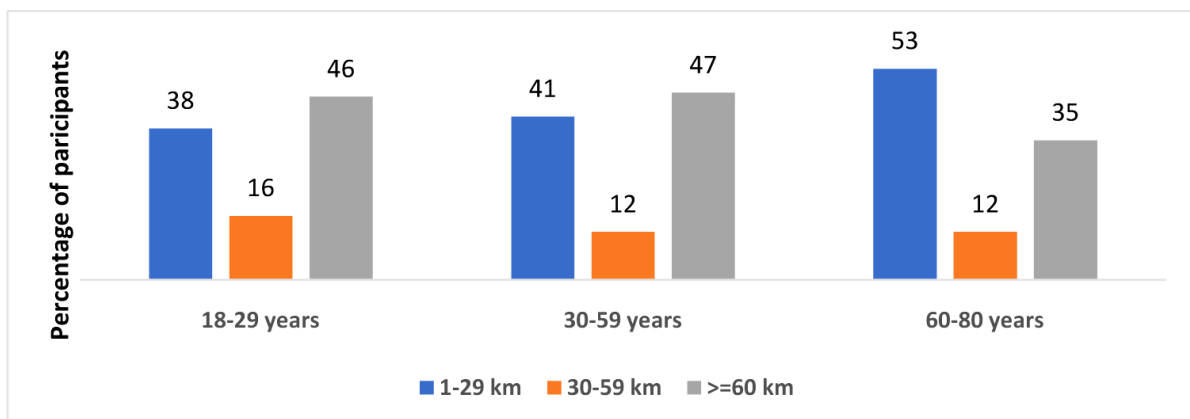


Figure 5. Distance ranges by age

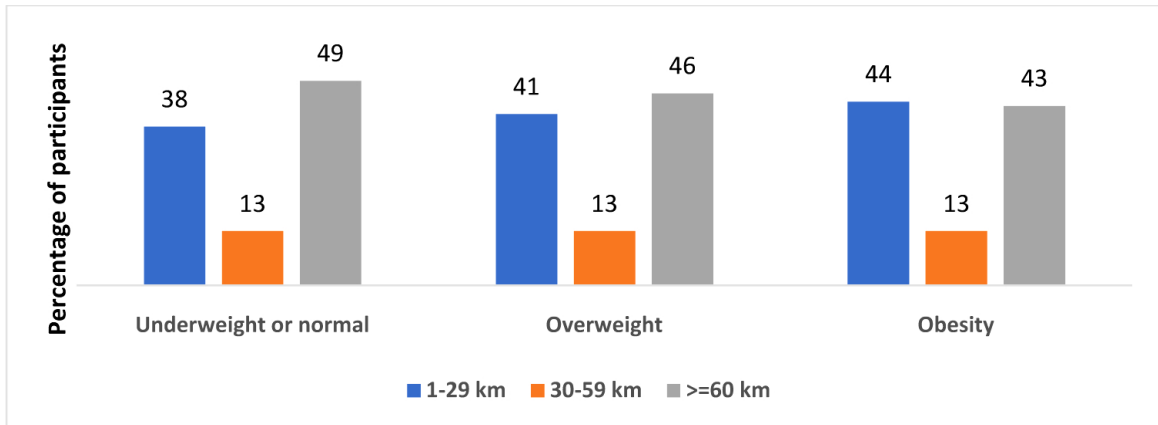


Figure 6. Distance ranges by body mass index

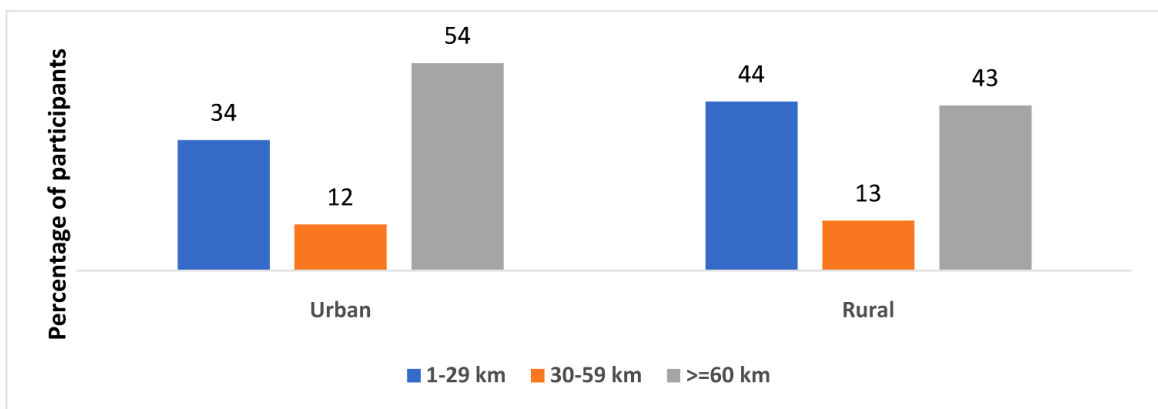


Figure 7. Distance ranges by area of residence

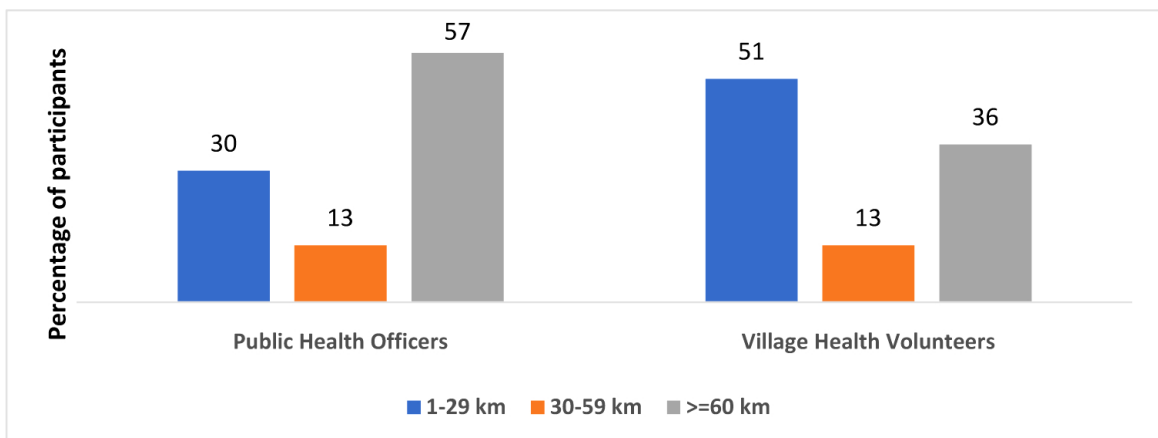


Figure 8. Distance ranges by type of participant

those participants who were overweight or obese, lived outside Bangkok, lived in rural areas, and were village health volunteers were less likely to achieve the project goal.

Discussion

This paper is among the first studies^(16,17) that tried to determine the achievement of Thailand's first national step-based intervention. The study

Table 3. Univariate and multivariate analysis of achieving the project goal at 60 km or higher

	Univariate logistic regression		Multivariate logistic regression	
	Crude Odds Ratio	95% Confidence Interval	Adjusted Odds Ratio	95% Confidence Interval
Sex: Male				
● Female	0.85	0.83-0.88	0.98	0.96-1.00
Age groups: 18-29 years				
● 30-59 years	1.04	1.01-1.07	1.58	1.53-1.62
● 60-80 years	0.63	0.61-0.66	1.37	1.31-1.44
BMI groups: Underweight or normal				
● Overweight	0.90	0.88-0.92	0.99	0.96-1.01
● Obesity	0.79	0.77-0.80	0.89	0.87-0.91
Regions: Bangkok				
● North	0.58	0.55-0.61	0.84	0.80-0.89
● Northeast	0.40	0.38-0.42	0.63	0.60-0.66
● Central	0.55	0.52-0.57	0.77	0.73-0.80
● South	0.57	0.54-0.60	0.88	0.84-0.92
Area of residence: Urban				
● Rural	0.66	0.65-0.67	0.83	0.82-0.85
User type: Public health officer				
● Village health volunteers	0.41	0.41-0.42	0.43	0.42-0.43

shows that around 46% of participants, who sent distance data, achieved the project goal. Men achieved the goal higher than women. Participants aged 30-59 years, not being obese, lived in Bangkok, lived in urban areas, and were public health officers, achieved the project goal higher than their counterparts. Moreover, being obese, living in rural areas, and were village health volunteers, were less likely to achieve the project goal by multivariate analysis.

This project seemed to be successful when considering a large number of registrations

(480,115). However, around half of all participants had never sent distance data through application (222,521), and only one fourth of participants achieved the goal of 60 km in 60 days (93,388). This may reflect a weak engagement among the participants that were recruited for the sake of number of registrations, the participation of village health volunteers was an example.⁽¹¹⁾ Moreover, inconvenience in device use might create a low self-report on distance. As shown in the findings that participants who lived in Bangkok or urban areas had a higher rate of achieving the project



goal. In addition, the awarding system that focused on a ‘first-come-first-serve’ basis i.e. finisher shirts and medals for the first 5,000 men and 5,000 women who achieved 60 km might be appropriate for only some segments of the participants, but demotivated others.⁽¹¹⁾ It was also worth noting that many national curfew policies from COVID-19 pandemic, such as city lockdowns, stay-at-home measures, and the closure of public places (recreational parks, stadiums, and gyms), were implemented during the late phase of the project.^(18,19) These COVID-19 pandemic and lockdown policies truly affected domestic physical activity during that period.⁽²⁰⁾

It is important to note that the step counting or distance reporting is one of the effective strategies to increase physical activities.^(7,8) However, the goal of the first national steps challenge of 60 km in 60 days, equaled to an average distance of one km a day, or 10 minutes a day, or 1,600 steps per day, was seemed to be too low, compared with the physical activity guideline of at least 30 minutes, or 7,000 steps per day.^(1,21,22) It was understandable that this goal was designed to raise awareness on physical activity promotion, and also make project more achievable and attractive. However, the target goal should focus on additional levels of physical activity increased from individual baseline instead of using fixed distance as an indicator of achievement. Taking into account a strong recommendation from WHO that “*some physical activity is better than none*”⁽²³⁾ and finding from study which indicated that a modest increase in steps significantly lowered

mortality.⁽²⁴⁾ Future project should set the goals individually. For instance, individual with a routine daily physical activity of 3 km or 3,000 steps or 30 minutes per day, should challenge with additional target of 2-3 km, 2,000-3,000 steps or 20-30 minutes of walking per day and keep those additions for 7–14 consecutive days. This personalized daily step goal system has been proved to be favorable for physically inactive individuals.⁽²⁵⁾

The findings in this study were in line with national surveys on physical activity, in particular the characteristics of participants that being male, adult, not being obese, living in Bangkok and urban areas that tended to be more active than the counterparts.⁽²⁶⁻²⁹⁾ The design of the step-based campaign in the next phase should take account of a variety of demographics of participants. For older adults or participants in rural areas, promoting a traditional intervention such as recreational or exercise clubs in parks is more conducive.^(30,31) For younger adults, an interesting rewarding system, a family or a peer challenge can be contested.^(9,32-34) While low-impact activities such as biking or swimming is more appropriate for obese participants.^(1,23,35) Moreover, partnering with local government units to provide facilities or fun activities might help engage more participants with various characteristics and increase the physical activity commitment in order to achieve the goal.

There were several strengths of the study. First, this study is among the first papers to analyze the achievement of the country-wide step-based intervention in Thailand. The results of the study would serve as a formative assessment

that provides valuable information for adjusting the activities and implementation in order to achieve the goal^(36, 37). Second, this study recruited a large number of participants across country. Third, the multivariate analysis controlling for several covariates such as sex, age, BMI, region, area of residence, and type of participant helped reduce the effect of confounders. However, numbers of limitations were addressed. First, distance data used in the analysis were acquired from self-reporting that participants did not daily submit the data through the application or non-validated distance data. Second, demographic data of participants was limited. Therefore, we cannot analyze primary outcome with levels of education, income or occupation. Third, there was no baseline distance; therefore, the authors cannot determine if the intervention directly affected on the distance taken by the participants.

Conclusions

The first Thailand national steps challenge using smartphone for self-reporting, brought a large number of registrations. However, only 46% of participants achieved the project goal at 60 km in 60 days. Participants who were male, aged 30-59 years, underweight or normal weight, lived in Bangkok, lived in urban areas, and were public health officers seemed to achieve the project goal higher than their counterparts. The study recommended that the national steps challenge should be continuously implemented by using more strategies to engage participants, with different characteristics, throughout the project.

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References

1. World Health Organization. Global recommendations on physical activity for health. Geneva: World Health Organization; 2010.
2. World Health Organization. Global health risks: mortality and burden of disease attributable to selected major risks. Geneva: World Health Organization; 2009.
3. Lee IM, Shiroma EJ, Lobelo F, Puska P, Blair SN, Katzmarzyk PT, et al. Effect of physical inactivity on major non-communicable diseases worldwide: an analysis of burden of disease and life expectancy. *Lancet*. 2012;380(9838):219-29.
4. World Health Organization. Global status report on noncommunicable diseases 2014. Geneva: World Health Organization; 2014.
5. Division of Physical Activity and Health, Department of Health, Ministry of Public Health. Thailand physical activity strategy 2018-2030. Bangkok: NC Concept; 2018. (in Thai)
6. Division of Physical Activity and Health, Department of Health, Ministry of Public Health. Physical activity policy options according to Thailand physical activity strategy



- 2018-2030. Bangkok: NC Concept; 2019. (in Thai)
7. Hall KS, Hyde ET, Bassett DR, Carlson SA, Carnethon MR, Ekelund U, et al. Systematic review of the prospective association of daily step counts with risk of mortality, cardiovascular disease, and dysglycemia. *Int J Behav Nutr Phys Act.* 2020;17(1):78.
 8. Harris T, Limb ES, Hosking F, Carey I, DeWilde S, Furness C, et al. Effect of pedometer-based walking interventions on long-term health outcomes: prospective 4-year follow-up of two randomised controlled trials using routine primary care data. *PLoS Med.* 2019;16(6):e1002836.
 9. Yao J, Tan CS, Chen C, Tan J, Lim N, Muller-Riemenschneider F. Bright spots, physical activity investments that work: National Steps Challenge, Singapore: a nationwide mHealth physical activity programme. *Br J Sports Med.* 2019;54(17):1047-8.
 10. Division of Physical Activity and Health, Department of Health, Ministry of Public Health. Thailand National Step Challenge [internet]. Nonthaburi: Division of Physical Activity and Health; 2020 [cited 2020 Oct 26]. Available from: <https://activefam.anamai.moph.go.th/home>. (in Thai)
 11. Division of Physical Activity and Health, Department of Health, Ministry of Public Health. Report on Thailand National Step Challenge season 1 [internet]. Nonthaburi: Division of Physical Activity and Health; 2020 [cited 2020 Oct 26]. Available from: <https://activefam.anamai.moph.go.th/%E0%B8%81%E0%B8%B2%E0%B8%A7%E0%B8%97%E0%B8%B2%E0%B9%83%E0%B8%88/dashboard-ss1>. (in Thai)
 12. Department of Health Service Support, Ministry of Public Health. Manual of village health volunteer in new era [internet]. Nonthaburi: Department of Health Service Support; 2011 [cited 2020 Nov 23]. Available from: http://phc.moph.go.th/www_hss/data_center/ifm_mod/nw/NewOSM-1.pdf. (in Thai)
 13. Keaitthaweepong K. The demand of mobile applications for elderly in Thailand. Bangkok: Thammasat University; 2017. (in Thai)
 14. World Health Organization. The Asia-Pacific perspective: redefining obesity and its treatment. Geneva: World Health Organization; 2000.
 15. Public Health Ministerial Regulations on the components of Department of Health. Royal Thai Government Gazette Volume 126, Section 98 Kor (Dec. 28, 2009) [internet]. Available from: <http://www.oic.go.th/FILEWEB/CABINFOCENTER17/DRAWER002/GENERAL/DATA0000/00000810.PDF>. (in Thai)
 16. Topothai T, Suphanchaimat R, Tangcharoensathien V, Putthasri W, Sukaew T, Asawutmangkul U, et al. Daily step counts from the First Thailand National Steps Challenge in 2020: a cross-sectional study. *Int J Environ Res Public Health.* 2020;17(22):8433. Available from: <https://www.mdpi.com/1660-4601/17/22/8433>.
 17. Topothai T, Piyathawomanan C, Asawutmangkul U. Lessons learned from developing and implementing National Steps Challenge Policy in Thailand. *Journal of Health Systems Research* 2020;14(4):478-88. (in Thai)
 18. Namwat C, Suphanchaimat R, Nittayasoot NI, S. Thailand's response against Coronavirus Disease 2019: challenges and lessons learned. *OSRI.* 2020;13(1):33-7.
 19. Royal Gazette. Official Statement of the Office of the Prime Minister RE : Declaration of an Emergency Situation pursuant to the Emergency Decree on Public Administration in Emergency Situations B.E. 2548 (2005). Bangkok: Royal Cabinet; 2020.
 20. Katewongsa P, Widyastaria DA, Saonum P, Haematulin N, Wongsingha N. The effects of COVID-19 pandemic on physical activity of the Thai population: evidence from Thailand's surveillance on physical activity 2020. *J Sport Health Sci.* 2020, <https://doi.org/10.1016/j.jshs.2020.10.001>.
 21. Tudor-Locke C, Craig CL, Brown WJ, Clemes SA, De Cocker K, Giles-Corti B, et al. How many steps/day are enough? For adults. *Int J Behav Nutr Phys Act.* 2011;8:79.
 22. Tudor-Locke C, Leonardi C, Johnson WD, Katzmarzyk PT, Church TS. Accelerometer steps/day translation of moderate-to-vigorous activity. *Prev Med.* 2011;53(1-2):31-3.
 23. World Health Organization. WHO guidelines on physical activity and sedentary behaviour for children and adolescents, adults and older adults. Geneva: World Health Organization; 2020.
 24. Ekelund U, Ward HA, Norat T, Luan J, May AM, Weiderpass E, et al. Physical activity and all-cause mortality across levels of overall and abdominal adiposity in European men and women: the European Prospective Investigation into Cancer and Nutrition Study (EPIC). *Am J Clin Nutr.* 2015;101(3):613-21.
 25. Kang M, Marshall SJ, Barreira TV, Lee JO. Effect of pedometer-based physical activity interventions: a meta-analysis. *Res Q Exerc Sport.* 2009;80(3):648-55.
 26. Liangruenrom N, Topothai T, Topothai C, Suriyawongpaisan W, Limwattananon S, Limwattananon C, et al. Do Thai people meet recommended physical activity level?: The 2015 National Health and Welfare Survey. *Journal of Health Systems Research.* 2017;11(2):205-20. (in Thai)

27. Topothai T, Liangruenrom N, Topothai C, Suriyawongpaisan W, Limwattananon S, Limwattananon C, et al. How much of energy expenditure from physical activity and sedentary behavior of Thai adults: The 2015 National Health and Welfare Survey. *Journal of Health Systems Research*. 2017;11(3):327-44. (in Thai)
28. Topothai T, Topothai C, Pongutta S, Suriyawongpaisan W, Chandrasiri O, Thammarangsi T. The daily energy expenditure of 4 domains of physical activity of Thai adults. *Journal of Health Systems Research*. 2015;9(2):168-80. (in Thai)
29. Liangruenrom N, Dumuid D, Craike M, Biddle SJH, Pedisic Z. Trends and correlates of meeting 24-hour movement guidelines: a 15-year study among 167,577 Thai adults. *Int J Behav Nutr Phys Act*. 2020;17(1):106. (in Thai)
30. World Health Organization. *Global action plan on physical activity 2018-2030* Geneva: World Health Organization; 2018.
31. Khamput T, Patsorn K, Thongbo T, Seunglee S, Keryai T, Sangsamritpol W, et al. Administration of physical activity promotion by twelve local administrative organizations in Thailand. *Journal of Health Systems Research*. 2019;13(1):63-89. (in Thai)
32. Duncan MJ, Brown WJ, Mummery WK, Vandelanotte C. 10,000 Steps Australia: a community-wide eHealth physical activity promotion programme. *Br J Sports Med*. 2018;52(14):885-6.
33. Macniven R, Engelen L, Kacen MJ, Bauman A. Does a corporate worksite physical activity program reach those who are inactive? Findings from an evaluation of the Global Corporate Challenge. *Health Promot J Austr*. 2015;26(2):142-5.
34. Mitchell M, White L, Lau E, Leahey T, Adams MA, Faulkner G. Evaluating the Carrot Rewards App, a population-level incentive-based intervention promoting step counts across two Canadian provinces: quasi-experimental study. *JMIR Mhealth Uhealth*. 2018;6(9):e178.
35. Division of Physical Activity and Health, Department of Health, Ministry of Public Health. *Thailand recommendations on physical activity, non-sedentary lifestyles, and sleeping*. Bangkok: NC Concept; 2017. (in Thai)
36. Vastine A, Gittelsohn J, Ethelbah B, Anliker J, Caballero B. Formative research and stakeholder participation in intervention development. *Am J Health Behav*. 2005;29(1):57-69.
37. Wiehagen T, Caito NM, Thompson VS, Casey CM, Weaver NL, Jupka K, et al. Applying projective techniques to formative research in health communication development. *Health Promot Pract*. 2007;8(2):164-72.