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Original article

Steps to and correlates of health-enhancing physical activity in adulthood: An intercultural study between German and Chinese individuals

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Abstract

Health-enhancing physical activity (HEPA) is a primary resource for improving physiological and psychosocial health. Stage models in the HEPA promotion area should fulfill three functions: description, intervention, and diagnosis. However, these functions have received insufficient attention, and research using an intercultural study paradigm has been rather scarce on this topic. The purpose of this study was to examine the three functions of a stage model by addressing the steps and correlates of HEPA behavior change process among adult samples from Germany and China. The 2071 adults (42% German and 58% Chinese), who were aged 27–55 years, completed self-administered questionnaires that assessed the quantity, intensity, and type of physical activity (PA) and assessed the stage of change. The following were also measured: five health correlates (i.e., fitness, physical complaints, body mass index, health satisfaction, and subjective well-being) and 10 psychosocial correlates (i.e., outcome expectations, affective attitude, barriers, self-efficacy, body concept, plans, intrinsic motivation, assessment of activity situation, activity emotions, and social support). The PA stages were significantly and positively correlated with the weekly energy consumption. In the health correlates and stages of change, all five health correlates significantly differed between the stages. In the psychosocial correlates and the stages of change, nine of 10 psychosocial correlates (with the exception of assessment of activity situation) significantly discriminated between the stages of change. In particular, nationality, gender, and education level are moderating factors for the characteristics of most health correlates across all stages of change. In addition, nationality, gender, and age moderated the relationship between the stage of change and some psychosocial correlates. The findings generally support the utility of a stage model for understanding German and Chinese adult HEPA behavior.

Keywords: Health correlates; Psychosocial correlates; Sedentary behavior; Stages of change

Introduction

Sedentary behavior and health-enhancing physical activity

It is well established that sedentary behavior is a major modifiable risk factor for health in adulthood.[1,2] However, high levels of sedentary behavior are becoming more prevalent in adults. For example, 60% of the adults in Europe are exercising less than once a week and only 9% of adults state

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they exercise regularly.[3] When adults from different industrialized regions were asked if they exercise for at least two hours every week with at least a moderate intensity, the response decreased to less than 10%.[1,4] When including the everyday life activities of at least moderate intensity "low actives" (i.e., individuals with less than 600 kcal/week), the results ranged from 12% to 43% in a comparison across 20 countries worldwide.[5]

The dose effect of physical activity (PA) physiologically increases with the volume (i.e., duration and frequency) and the quality (i.e., intensity and type) of activity.[6] In regard to the types of activity, "exercise" (e.g., fitness training or aerobic exercise) was more effective for improving fitness and health than "sport" (e.g., soccer, golf, or gymnastics) or "everyday life activities" (e.g., gardening, shopping, or walking to the bus station).[7] Previous intervention research with highly sedentary adults has shown that initiating exercise for at least 90 minutes per week in a group training program and at least 90 minutes of moderate-intensity "everyday life activity" per week significantly improves physiological and psychological health markers within 1 year.[8]

Health-enhancing physical activity (HEPA) is any form of PA that benefits health and functional capacity without undue harm or risk.[9] The recommendations for HEPA in adulthood differ considerably.[10] However, there is agreement that recommendations should include: quantitative advice (e.g., "accumulate 2–3 hours per week or more of PA of at least moderate intensity") and qualitative advice (e.g., "include in the above amount of physical activity exercise to promote endurance, strength, flexibility and relaxation systematically").[6,9]

The process of behavioral change

The process of progressing from sedentary behavior to habitual HEPA can be understood as a behavioral change process that substitutes old (i.e., sedentary) behaviors or patterns and replaces them with new (i.e., more active) behaviors or patterns. This process may take a long time—sometimes years—but the process seems to consist of a sequence of discrete, qualitative stages.[11] The HEPA furthermore represents a complex behavior that encompasses specific aims, types of PA, and factors influencing this behavior such as individual factors (e.g., barriers, self-efficacy, motivation) and contextual factors (e.g., social support, activity opportunities). Some researchers argue that PA is a set of different behaviors, not a single behavior (an example of a single behavior is smoking).[12] In regard to this complexity, increasing the levels of HEPA behavior through intervention in the general population must address and focus on relevant psychosocial correlates of PA behavior change outlined by past research.[13–15] Thus, any attempt to model the process from sedentary behavior to habitual HEPA via stage models may be a simplification of reality and may be based on assumptions rather than on evidence.

The function of stage models

The definition and investigation of stage models can be performed with specific scientific and practical interests. Such models can subsequently have varied functions: (1) *the function of description.* The special focus of this function on the one hand is primarily to describe the process of behavior change from sedentary behavior to HEPA behavior as a sequence of discrete, qualitative stages, and on the other hand to correlate it with important health variables and with psychosocial variables. For example, the Health Action Process Approach (HAPA) model[16] attempts to describe (1) the interaction between motivational processes that subsequently lead to goal setting and volitional processes that lead to the actual targeting of health behavior change; and (2) the correlation with sociocognitive factors, primarily risk perception, outcome expectations, self-efficacy, intention, action plans, and social support; (2) *The function of intervention*. The special focus of the function is to undertake suitable measures that facilitate the progression of individuals to higher stages of the behavior change process, and thus closer to the ultimate aim of habitual HEPA. The best known example of such modeling is the Transtheoretical Model (TTM),[17] although this model was originally developed to change different risk behaviors (e.g., smoking). Identifying factors associated with different levels of PA is an important precondition for the planning of any intervention in health promotion; and (2) .*The function of diagnosis*. A third focus could be the diagnosis of the PA behavior status as a risk factor or as a health resource in association with the diagnosis of health parameters (e.g., fitness, complaints, risk factors). In large samples, establishing valid correlations between the stages of change and health parameters may make it possible to distinguish the specific health status from the stage of activity. Until recently, this function has not been a perspective that had utility in the construction of physical activity-related behavior change models.

Types of stage models

Stage models have been previously described and discussed from a variety of perspectives.[11,18,19] The following stage models have influenced the conceptualization of the proposed Four Steps from Inactivity to Health-enhancing Physical Activity (FIT) model in numerous ways.

The TTM proposes five stages: (1) the precontemplation stage (i.e., not currently considering performing the target health behavior); (2) the contemplation stage (i.e., considering performing the target health behavior, but not doing so yet); (3) the preparation stage (i.e., preparing and planning for the target health behavior); (4) the action stage (i.e., actively performing the target health behavior, but for less than 6 months); and (5) the maintenance stage (i.e., having consistently performed the target health behavior for 6 months or more).[17] In addition, the researchers conceptualized "relapse", which itself is not defined as a stage, but is defined as the return from "Action" or "Maintenance" to an earlier stage. The TTM takes into account the issues of self-efficacy, decisional

balance (i.e., weighing the pros and cons), and 10 processes of change, including five cognitive strategies (e.g., increasing consciousness) and five behavioral strategies (e.g., use of a support partner). In the discussion of the results of the existing validation studies,[20] the studies emphasize that it is important to clearly define "physical activity" and that there is some evidence to support the existence of a relapse stage.

In the HAPA model, the motivational and volitional processes are focused on understanding the process of change in health behavior.[16] Thus, three HAPA model stages can be assessed: (1) the nonintentional stage; (2) the intentional stage; and (3) the action stage. Integrated mediators of the model include sociocognitive variables such as risk perception, outcome expectations (pros and cons), self-efficacy, intention, action plans, and social support.

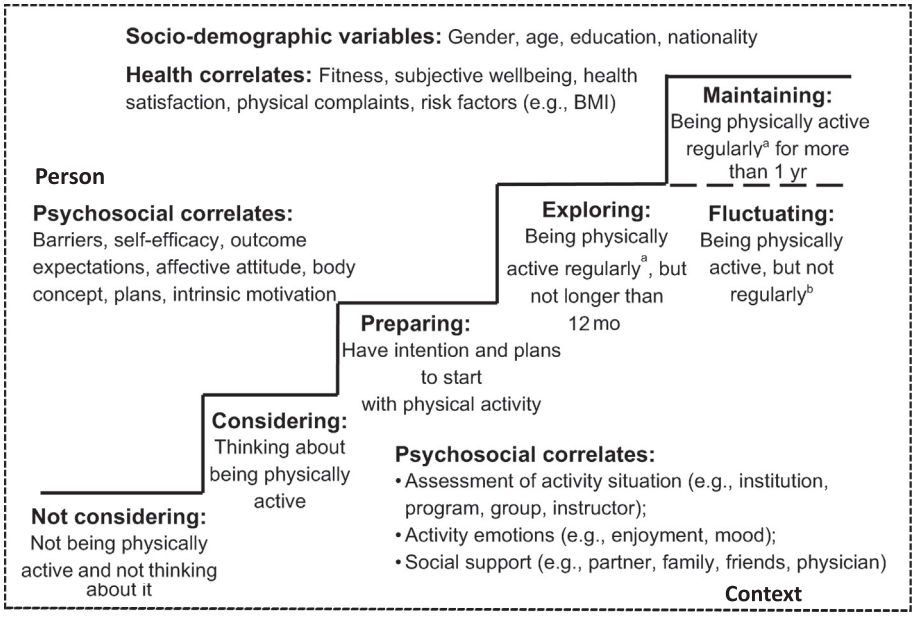
The four steps from inactivity to health-enhancing physical activity model

Based on the previous models, the **F**our Steps from **I**nactivity to Health-enhancing Physical Act**i**vity (FIT) model is intended to fulfill the three functions described previously: (1) description, (2) intervention, and (3) diagnosis. Thus, the examined behavioral change process is concentrated on the time span from sedentary behavior to habitual HEPA behavior. Complementing the current adult recommendations for HEPA, the following physical behavior factors were integrated into the conceptualization of "physical activity": regularity, frequency, intensity, and type of activity. From this perspective, "physical activity" can be described as activity that is conducted in everyday life (e.g., riding a bicycle to work), in sports (e.g., soccer, tennis), and in exercise (e.g., jogging, fitness training, tai chi), all of which should be performed with at least moderate exertion (i.e., resulting in sweating and/or breathing faster). The frequency of HEPA of moderate intensity (i.e., approximately 800 kcal/week) at 120 minutes is equivalent to the lowest HEPA criterion, according to the current adult PA recommendations. However, as research shows, this amount is already health-effective for highly sedentary adults.[8,21]

As Fig. 1 shows, the model comprises four steps—ranging from sedentary behavior to maintaining HEPA behavior—but it has six stages. The introductory text for the stage algorithm explains the concept of PA, as follows:

> "PA includes activities of daily life (such as going to work or shopping by bike or by foot, and climbing stairs) and sport activities or exercises (such as jogging, swimming, fitness-training in a club or in the community, playing football or badminton). Only think of such activities you do with at least moderate intensity (some sweating and/or some breathlessness)."[22,23]

The stage algorithm comprises six statements: (1) "I am not physically active, and I am not thinking about being physically active in the future"; (2) "I am not physically active, but I am thinking about being physically active soon"; (3) "I am not physically active, but I am just making decisions and building up plans to start physical activity"; (4) "Yes, I am physically active every week, and have accumulated at least 120 minutes, but for less than twelve months"; (5) "Yes, I am physically active, but not regular every week, or have not accumulated at least 120 minutes every week"; (6) "Yes, I am physically active every week and have accumulated at least 120 minutes, and I have done this for twelve months or more".



[a] "Regularly" means at least 120 minutes per week.
[b]: "Not regularly" means not regular every week and not in every week for accumulated at least 120 minutes.
BMI = body mass index; FIT model = Four Steps from Inactivity to Health-enhancing Physical Activity model.

Fig. 1. The FIT model of health-enhancing physical activity behavior.

This indicates that the FIT Model integrates—on the basis of a well-founded conceptualization of "physical activity"—the main stages of the TTM, but it is supplemented by the stage "fluctuation." The time requirement of 12 months for the "exploring" stage is doubled in comparison to the "action stage" in the TTM. This rationale was based on previously conducted research regarding dropout from and adherence to HEPA.[8,24]

The diagnosis function integrates the following health correlates into the FIT model: fitness, physical complaints, body mass index (BMI), health satisfaction, and subjective well-being. Under the intervention function of the model, it is important to integrate the psychosocial correlates of the person and the context into the FIT model.

The following relevant correlates were integrated into the FIT model and were chosen on the basis of appropriate current evidence and the validation results of TTM and HAPA.[25] The correlates are outcome expectations, affective attitude, barriers, self-efficacy, body concept, plans, and intrinsic motivation from a personal perspective, as well as the assessment of activity situation, activity emotions, and social support from a contextual perspective. Sociodemographic variables (i.e., moderators)—especially the variables of gender, age, education or ethnic/cultural affiliation—may influence the process of behavior change from sedentary behavior to HEPA behavior.[13]

The stage models with all three functions in HEPA promotion have received insufficient attention and research using an intercultural study paradigm has been rather scarce on this topic. The purpose of this study was to examine these functions of the FIT model by addressing the steps and correlates of the HEPA behavioral change process among adult samples from Germany and China. The research questions were the following: (1) "Do the physical activity stages of the change correlate with energy consumption per week, as measured by daily life activity, sport, and exercise (e.g., time, intensity)?"; (2) "Do the health correlates significantly differ between nationality, gender, age group, education level, and the stages of change? Are the effects of socio-demographic variables different on certain stages of change (i.e., is there a significant interaction with the stages)?"; and (3) "Do the psychosocial correlates significantly differ between nationality, gender, age group, education level and stages of change? Are the effects of sociodemographic variables different at certain stages of change (i.e., is there a significant interaction with the stages)?"

Methods

Prestudies

A measurement tool, the Adults Physical Activity Behavior survey, was first developed in the German language as an online questionnaire and in a hardcopy version. It was validated in a German adult sample ($n = 176$; 44.9% women, 27–55 years, mean age 38.4 years). After modifying it, the measurement tool was translated into Chinese by a standard back-translation technique. Based on the results of the Chinese prestudy ($n = 226$; 52% women, 27–55 years, mean age 39.2 years), some further modifications had to be made. In general, the reliability and validity of the questionnaire packets in German and in Chinese were acceptable.[22,23]

Participants and procedures

As in the prestudies, the participants of the main study were middle-aged adults ranging from 27–55 years. This age range was selected because most German and Chinese people of this age group are employed and HEPA is more important for this population to maintain physical wellbeing. The German and Chinese study participants were mostly recruited from factories. In addition, students from Wuhan University (Wuhan, China) and Bayreuth University (Bayreuth, Germany) gathered data from parents, relatives, and friends of the family. The questionnaires required 15–20 minutes to complete. In this way, 2404 questionnaires were gathered overall, but 81 questionnaires in Germany (8.6%) and 252 questionnaires in China (17.3%) could not be used because of incomplete answers or obvious wrong answers.

Table 1 shows that the valid sample of 2071 participants had fairly good distribution of the sociodemographic variables (i.e., gender, age, education, and nationality) and in the six stages of behavior change. Missing data in subsequent analyses resulted from incomplete answers in the questionnaire. The missing data were subjected to pairwise deletion.

Questionnaires

Table 2 provides an overview of the questionnaires with respect to activity behavior, health correlates, and psychosocial correlates.

Sociodemographic variables

Participants were asked to give information regarding gender, age, education level, nationality, height and weight.

Table 1
Characteristics of the 2071 participants in the main study.

	Germany	China	Total
Gender			
Male	306 (35.4)	586 (48.6)	892 (43.1)
Female	559 (64.6)	620 (51.4)	1179 (56.9)
Age (y)			
27–40	393 (45.4)	822 (68.2)	1215 (58.7)
41–55	472 (54.6)	384 (31.8)	856 (41.3)
Education[a]			
Lower	380 (43.9)	346 (28.7)	726 (35.1)
Higher	485 (56.1)	860 (71.3)	1345 (64.9)
Stage			
Not considering	70 (8.1)	147 (12.2)	217 (10.5)
Considering	97 (11.2)	273 (22.6)	370 (17.9)
Preparing	66 (7.6)	148 (12.3)	214 (10.3)
Exploring	71 (8.2)	144 (11.9)	215 (10.4)
Fluctuating	164 (19.0)	201 (16.7)	365 (17.6)
Maintaining	397 (45.9)	293 (24.3)	690 (33.3)
Total	865 (41.8)	1206 (58.2)	2071 (100)

Data are presented as mean (%).
[a] Qualification for college/university is the distinction point.

Table 2
The adult physical activity behavior survey measurement tool.

Activity behavior		
Stage algorithm	Brehm et al[22]	Items (see the FIT Model description in main text).
Type of activity	Brehm et al[22]	Five categories for sports and exercise activities (e.g., fitness training); six categories for everyday life activities (e.g., walking for shopping, walking in the work place).
Quantity and intensity of act	Brehm and Sygusch 2008[26]	*Quantity:* (1) once or occasionally per mo; (2) 2–3 times per mo; (3) <1 h per wk; (4) 1–2 h per wk; (5) 2–4 h per wk; (6) >4 h per wk. *Intensity:* (1) mild (i.e., no sweating and no shortness of breath); (2) moderate (i.e., some sweating and/or some shortness of breath); (3) vigorous (i.e., heavy sweating and/or considerable shortness of breath).
Health correlates		
Fitness	Bös et al 2002[27]	Four factors (i.e., strength, coordination, endurance, flexibility) with five items each. The five-point scale ranges from "I am not able to do this" (1 point) to "no problems" (5 points).
Health satisfaction	Fahrenberg et al 2000[28]	Seven items (e.g., "With my general health status I am …") are answered on a seven-point scale ranging from "very satisfied (1 point)" to "very unsatisfied" (7 points).
Subjective wellbeing (positive and negative)	Abele and Brehm 1986[29]	"How did you feel in the last week?" 12 positive items (e.g., vigorous, relaxed). 9 negative items (e.g., nervous, fatigue). Five-point scale ranging from "not at all" (1 point) to "extremely" (5 points).
Physical complaints	Fahrenberg 1994[30]	15 items (e.g., headache, heart pain, difficulty in sleeping), answered on a five-point scale ranging from "hardly ever" (1 point) to "nearly every day" (5 points).
Psychosocial correlates		
Outcome expectations	Brehm and Pahmeier 2006[31]	"By means of regular physical activity, I expect…" 18 items such as "to improve my fitness". Seven-point scale from "not true at all" (1 point) to "exactly true" (7 points). Four factors (e.g., positive health, social experiences).
Affective attitudes	Brand[32]	"When I am thinking of participating in physical activity, I will feel…" Four items such as "comfortable", "satisfied". Seven-point scale ranging from "not true at all" (1 point) to "exactly true" (7 points).
Barriers	Brehm et al[22]	"Please state the degree to which you agree or disagree concerning the reasons for not participating in physical activity". 15 items such as "My family burdens occupy a lot of my time". Seven-point scale ranging from "not agree at all" (1 point) to "extremely agree" (7 points). Four factors (e.g., lack of motivation).
Self-efficacy	Schwarzer[16]	"I am confident that I can participate in a planned physical activity, even if…" Seven items (e.g., "…I am tired"). Five-point scale ranging from "not at all confident" (1 point) to "extremely confident" (5 points). Two factors (i.e., maintenance, resumption).
Body concept	Brehm and Sygusch 2008[26]	"How do you evaluate your body?" Six items such as "I am satisfied with my appearance". Seven-point scale ranging from "not true at all (1 point)" to "exactly true" (7 points).
Plans	Lippke et al 2005[33]	"I am planning in detail…" Five items such as "…which physical activity I will perform". Five-point scale ranging from "not at all true" (1 point) to "exactly true" (5 points).
Intrinsic motivation	Seelig and Fuchs[34]	"I intend to be physically active regularly within the next weeks and months, because …"

(*continued on next page*)

Table 2 (*continued*)

		Three items such as "participating in physical activity is a part of my life". Six-point scale ranging from "not true at all" (1 point) to "exactly true" (6 points).
Social support (family/friends)	Sallis et al 1987[35]	Three items family and three items friends (e.g., "friends encourage me to be physically active". Five-point scale ranging from "never" (1 point)" to "very often" (5 points).
Assessment of activity situation	Brehm et al[22]	"Please rate how important the following aspects are when you are performing physical activity"; Three items: "do physical activity with others", "do physical activity under professional guidance", "do physical activity in nice sites such as a sport club, gym or park". Six-point scale ranging from "not at all important" (1 point) to "extremely important" (6 points).
Activity emotions	Brehm et al[22]	"How do you evaluate your situation when you are physically active?" Two items: "I have a lot of fun when I am physically active" and "I am very contented with the external environment of my physical activities (e.g., facilities)". Six-point scale ranging from "not at all important" (1 point) to "extremely important" (6 points).

FIT = Four steps from inactivity to health-enhancing physical activity.

Energy consumption

From the quantity (i.e., time per week) and the intensity of activity (i.e., three levels), the energy consumption (in kcal/wk) was calculated for sports and exercise activities and for everyday life activities (based on Ainsworth et al[36] and Woll et al[37]), as follows: mild intensity (i.e., no sweating and no shortness of breath), 4 kcal/min; moderate intensity (i.e., some sweating and/or some shortness of breath), 6.5 kcal/min; and vigorous intensity (i.e., heavy sweating and/or heavy shortness of breath), 9 kcal/min.

Body mass index

BMI (kg/m^2) was derived from the participants' self-reported weight and height.

Data analysis

The association between PA stages and weekly energy consumption were examined by using an analysis of variance (ANOVA) with *post hoc* comparison.

ANOVA with *post hoc* comparison (i.e., the Duncan test) was further employed to test the relationship between the health correlates and the stages of change and sociodemographic variables (e.g., nationality, gender, age group, education level) and the relationship between psychosocial correlates and the stages of change and sociodemographic variables (e.g., nationality, gender, age group, education level).

Results

Energy consumption across the stages of change: research question 1

To evaluate the validity of the stage algorithm, the relationship between stages and the corresponding energy consumption were examined. The distribution of the average weekly energy consumption per stage showed that the consumption in the inactive stages—"not considering" (222 kcal/wk), "considering" (257 kcal/wk), and "preparing" (479 kcal/wk)—were clearly below the assumed lowest level of HEPA (800 kcal/week), whereas the active stages—"exploring" (1620 kcal/week), "maintaining" (2048 kcal/week), and "fluctuation" (1197 kcal/week)—were clearly above this level.

By using ANOVA, differences of energy consumption were tested with respect to gender, age group, education level, nationality, and stage of change. Results demonstrated that some interactions existed between the stage variables and the four sociodemographic variables in fewer than 10 participants. Therefore, only the main effects of independent variables were conducted. Table 3 presents the findings.

The findings demonstrate that energy consumption per week significantly differed by gender ($F = 18.27$; $p = 0.001$; $\eta^2 = 0.009$) and by the stage of change ($F = 433.11$; $p < 0.001$; $\eta^2 = 0.512$). Greater effect sizes (η^2) of the stages moreover demonstrated a close relationship between the stage of change and the energy consumption. Furthermore, *post hoc* analysis was conducted to examine whether significant differences exist between adjacent stages with respect to energy

Table 3
The ANOVA results for the volume of energy consumption per week by the 2071 study participants.

Dependent variable	Independent variable	Degree	F	*p*	η^2
Energy consumption per wk	Gender	1	18.27***	0.000	0.009
	Nationality	1	0.01	0.916	0.000
	Age group	1	0.00	0.955	0.000
	Education level	1	0.29	0.591	0.000
	Stage	5	433.11***	0.000	0.512

***$P < 0.001$.
ANOVA = analysis of variance.

Table 4
The mean and standard deviation (in parentheses) of health correlates across sociodemographic variables and the main effects of sociodemographic variables on health correlates based on ANOVA tests (n = 2034–2068).[a]

Moderators	Nationality		Gender		Age group		Education level	
	Germany (n_{max} = 865)	China (n_{max} = 1206)	Male (n_{max} = 892)	Female (n_{max} = 1179)	Younger ones (n_{max} = 1215)	Older ones (n_{max} = 856)	Lower education (n_{max} = 726)	Higher education (n_{max} = 1345)
Health Correlates (n)								
Fitness (2034)[b]	4.05 (0.66)	3.84 (0.71)	4.16(0.63)	3.75 (0.69)	4.01 (0.65)	3.82 (0.74)	3.74 (0.74)	4.03 (0.65)
	$F_{1,2004} = 28.21$***, $\eta^2 = 0.014$		$F_{1,2004} = 209.69$***, $\eta^2 = 0.095$		$F_{1,2004} = 50.59$***, $\eta^2 = 0.025$		$F_{1,2004} = 18.43$***, $\eta^2 = 0.009$	
Positive subjective Wellbeing (2068)[c]	3.35 (0.72)	2.98 (0.75)	3.15 (0.76)	3.12 (0.76)	3.07 (0.77)	3.22 (0.74)	3.18 (0.73)	3.10 (0.77)
	$F_{1,2038} = 49.05$***, $\eta^2 = 0.024$		$F_{1,2038} = 0.53$, $\eta^2 = 0.000$		$F_{1,2038} = 1.35$, $\eta^2 = 0.001$		$F_{1,2038} = 3.75$, $\eta^2 = 0.002$	
Negative subjective Wellbeing (2068)[c]	2.26 (0.73)	1.97 (0.70)	2.07 (0.71)	2.11 (0.73)	2.13 (0.72)	2.04 (0.72)	2.10 (0.72)	2.09 (0.73)
	$F_{1,2038} = 119.49$***, $\eta^2 = 0.055$		$F_{1,2038} = 0.64$, $\eta^2 = 0.000$		$F_{1,2038} = 11.08$**, $\eta^2 = 0.005$		$F_{1,2038} = 0.78$, $\eta^2 = 0.000$	
Health satisfaction (2068)[d]	5.18 (1.07)	4.21 (1.29)	4.65 (1.30)	4.59 (1.29)	4.47 (1.32)	4.82 (1.22)	4.69 (1.22)	4.57 (1.33)
	$F_{1,2038}$=156.59***, η^2=0.071		$F_{1,2038} = 3.77$, $\eta^2 = 0.002$		$F_{1,2038} = 3.00$, $\eta^2 = 0.001$		$F_{1,2038} = 2.45$, $\eta^2 = 0.001$	
Physical complaints (2068)[e]	2.08 (0.62)	2.14 (0.79)	2.00 (0.71)	2.20 (0.73)	2.12 (0.73)	2.11 (0.72)	2.18 (0.74)	2.08 (0.72)
	$F_{1,2038} = 0.94$, $\eta^2 = 0.000$		$F_{1,2038} = 26.19$***, $\eta^2 = 0.013$		$F_{1,2038} = 0.14$, $\eta^2 = 0.000$		$F_{1,2038} = 0.75$, $\eta^2 = 0.000$	
BMI (2049)[f]	24.76 (4.28)	22.51 (3.37)	24.42 (3.52)	22.70 (4.07)	22.80 (3.77)	24.34 (3.97)	24.16 (4.10)	23.08 (3.80)
	$F_{1,2019} = 221.41$***, $\eta^2 = 0.099$		$F_{1,2019} = 149.16$***, $\eta^2 = 0.069$		$F_{1,2019} = 38.43$***, $\eta^2 = 0.019$		$F_{1,2019} = 4.89$, $\eta^2 = 0.002$	

Data are presented as mean (SD).
ANOVA = analysis of variance; BMI = body-mass index; M = mean; n_{max} = maximum number; SD = standard deviation.
*$p < 0.05$.
**$p < 0.01$.
***$p < 0.001$.
[a] Indicates missing data.
[b] Fitness is based on a five-point scale ranging from "not able to do this" (1 point) to "no problems" (5 points).
[c] Subjective wellbeing (positive and negative) is based on a five-point scale ranging from "not at all" (1 point) to "extremely" (5 points).
[d] Health satisfaction is based on a seven-point scale ranging from "very unsatisfied" (1 point) to "very satisfied" (7 points).
[e] Physical complaints are based on a five-point scale ranging from "hardly ever" (1 point) to "nearly every day" (5 points).
[f] BMI is calculated by an individual's weight (kg) divided by the square of the individual's height (m) (i.e., kg/m^2).

Table 5
The mean and standard deviation (in parentheses) of health correlates across the stages and results from group comparisons ($n = 2045–2068$).[f]

Physical activity stage	Not Considering ($n_{max} = 217$)	Considering ($n_{max} = 370$)	Preparing ($n_{max} = 214$)	Exploring ($n_{max} = 215$)	Fluctuating ($n_{max} = 365$)	Maintaining ($n_{max} = 690$)	
Health Correlates (n)							
Fitness (2045)[g]	3.43[a] (0.81)	3.61[b] (0.69)	3.78[c] (0.64)	4.02[d] (0.60)	3.96[d] (0.63)	4.27[e] (0.53)	$F_{5,2039} = 87.69$***, $\eta^2 = 0.177$
Positive subjective Wellbeing (2068)[h]	2.93[a] (0.76)	2.86[a] (0.70)	2.95[a] (0.75)	3.17[b] (0.73)	3.09[b] (0.75)	3.41[c] (0.71)	$F_{5,2062} = 38.05$***, $\eta^2 = 0.084$
Negative subjective Wellbeing (2068)[h]	2.20[a,b] (0.77)	2.20[a,b] (0.75)	2.27[a] (0.82)	2.10[b,c] (0.70)	2.06[c,d] (0.68)	1.96[d] (0.67)	$F_{5,2062} = 10.02$***, $\eta^2 = 0.024$
Health satisfaction (2068)[i]	4.23[a] (1.26)	4.04[a] (1.32)	4.07[a] (1.30)	4.51[b] (1.22)	4.65[b] (1.21)	5.23[c] (1.07)	$F_{5,2062} = 66.12$***, $\eta^2 = 0.138$
Physical complaints (2068)[j]	2.24[a] (0.82)	2.34[a] (0.76)	2.33[a] (0.77)	2.08[b] (0.70)	2.10[b] (0.72)	1.91[c] (0.61)	$F_{5,2062} = 24.29$***, $\eta^2 = 0.056$
BMI (2060)[k]	23.74[a] (4.40)	23.32[a,b] (4.48)	23.75[a] (4.29)	22.98[b] (3.67)	23.85[a] (4.03)	23.26[a,b] (3.33)	$F_{5,2054} = 2.24$*, $\eta^2 = 0.005$

Data are presented as mean (SD).
BMI = body-mass index; M = mean; n_{max} = maximum number; SD = standard deviation.
*$p < 0.05$.
***$p < 0.001$.
[a,b,c,d,e] Indicates a significant difference between subgroups (Duncan test).
[f] Indicates missing data.
[g] Fitness is based on a five-point scale ranging from "not able to do this" (1 point) to "no problems" (5 points).
[h] Subjective wellbeing (positive and negative) is based on a five-point scale ranging from "not at all" (1 point) to "extremely" (5 points).
[i] Health satisfaction is based on a seven-point scale ranging from "very unsatisfied" (1 point) to "very satisfied" (7 points).
[j] Physical complaints is based on a five-point scale ranging from "hardly ever" (1 point) to "nearly every day" (5 points).
[k] BMI is calculated by an individual's weight (kg) divided by square of the individual's height (m) (i.e., kg/m_2).

consumption. The results show that there were no significant differences between adjacent stages of the three inactive stages ($p > 0.05$), whereas there were significant differences between the "preparing" and "exploring" stages ($p < 0.01$), between the "preparing" and "fluctuating" stages ($p < 0.01$), between the "exploring" and "fluctuating" stages ($p < 0.01$), between the "exploring" and "maintaining" stages ($p < 0.01$), and between the "fluctuating" and "maintaining" stages ($p < 0.01$).

Health correlates across sociodemographic variables and stages of change: research question 2

Tables 4 and 5 present the results of the group comparisons between nationality, gender, age group, education level, and the six stages of behavior change in relation to health correlates.

The results from ANOVA (Table 4) revealed that nationality had a significant main effect on all health correlates, except for physical complaints. Compared to the Chinese adults, the German adults had better fitness, higher subjective wellbeing (both positive and negative), greater health satisfaction, and a higher BMI index. The two demographic variables, gender and age group, each had significant main effects on three of six health correlates. In particular, males had fewer physical complaints, a higher BMI index, and were fitter in comparison to females. Compared to older adults, younger adults had higher negative subjective wellbeing and a higher BMI index, but they were fitter. The education level had a significant main effect only on fitness. Adults with a higher education level were fitter than adults with a lower education level.

The results from ANOVA (Table 5) indicate significant main effects of the PA stages on all six health correlates. Adults at the higher stages of change had significantly better health correlates than adults at the lower stages of change. The effect sizes (η^2) were strong for the association between the PA stages and fitness and between the PA stages and health satisfaction; medium for the associations between PA stages and positive subjective well-being and between PA stages and physical complaints; and small for the association between the PA stages and negative subjective wellbeing and between the PA stages and the BMI. *Post hoc* tests revealed that adults at the active stages (i.e., "exploring", "fluctuating", and "maintaining") showed higher descriptive values in fitness, positive subjective well-being, and health satisfaction, and they differed significantly in these health correlates from inactive adults (i.e., "not considering", "considering", and "preparing"). In addition, the health correlates of the adults at the "maintaining" stage were superior to the correlates of adults at the "exploring" and "fluctuating" stages. The trend for physical complaints across these stages was the opposite of this notion. The results moreover indicated that adults at the "fluctuating" and "maintaining" stages significantly differed from adults at the inactive stages in negative subjective well-being, whereas adults at these two active stages did not significantly differ in BMI from adults at the inactive stages.

Results of the analysis of interaction effects between stages of change and sociodemographic variables revealed significant interaction effects between the stages and nationality on fitness ($F_{5,\ 2004} = 3.14$; $p = 0.008$; $\eta^2 = 0.008$), negative subjective wellbeing ($F_{5,\ 2038} = 3.58$; $p = 0.003$; $\eta^2 = 0.009$), physical complaints ($F_{5,\ 2038} = 2.27$, $p = 0.045$, $\eta^2 = 0.006$), and BMI ($F_{5,\ 2019} = 8.29$; $p = 0.000$; $\eta^2 = 0.020$). The descriptive values showed that adults in both countries improved their fitness level as the stage increased, but the fitness gain was higher for German adults from the "not considering" stage to the "maintaining" stage. In addition, the negative subjective wellbeing perception of the German adults improved only in the active stages. By contrast, the Chinese adults felt less negative subjective wellbeing with each increasing stage. The

Table 6
The mean and standard deviation (in parentheses) of psychosocial correlates across sociodemographic variables and the main effects of sociodemographic variables on psychosocial correlates in ANOVA test (n = 1258−2064).[a]

Moderators	Nationality		Gender		Age group		Education Level	
	Germany (n_{max} = 865)	China (n_{max} = 1206)	Male (n_{max} = 892)	Female (n_{max} = 1179)	Younger ones (n_{max} = 1215)	Older ones (n_{max} = 856)	Lower education (n_{max} = 726)	Higher education (n_{max} = 1345)
Psychosocial Correlates (n)								
Barriers (2058)[b]	2.49 (1.03)	2.85 (1.10)	2.62 (1.08)	2.76 (1.09)	2.72 (1.05)	2.66 (1.13)	2.86 (1.13)	2.61 (1.05)
	$F_{1,2028} = 0.86$, $\eta^2 = 0.000$		$F_{1,2028} = 9.66$**, $\eta^2 = 0.005$		$F_{1,2028} = 1.13$, $\eta^2 = 0.001$		$F_{1,2028} = 0.60$, $\eta^2 = 0.000$	
Self-efficacy (2055)[c]	3.53 (0.85)	2.85 (0.78)	3.16 (0.88)	3.12 (0.88)	3.09 (0.85)	3.20 (0.91)	3.04 (0.89)	3.18 (0.87)
	$F_{1,2025} = 113.50$***, $\eta^2 = 0.053$		$F_{1,2025} = 9.01$**, $\eta^2 = 0.004$		$F_{1,2025} = 0.02$, $\eta^2 = 0.000$		$F_{1,2025} = 0.91$, $\eta^2 = 0.000$	
Outcome expectations (2058)[d]	4.39 (0.96)	4.76 (1.25)	4.65 (1.30)	4.57 (1.03)	4.70 (1.21)	4.47 (1.05)	4.46 (1.05)	4.69 (1.20)
	$F_{1,2028} = 24.43$***, $\eta^2 = 0.012$		$F_{1,2028} = 0.89$, $\eta^2 = 0.000$		$F_{1,2028} = 7.92$**, $\eta^2 = 0.004$		$F_{1,2028} = 1.93$, $\eta^2 = 0.001$	
Affective attitude (2060)[e]	5.31 (1.29)	5.04 (1.49)	5.20 (1.45)	5.12 (1.39)	5.16 (1.42)	5.15 (1.40)	4.98 (1.43)	5.25 (1.40)
	$F_{1,2030} = 0.28$, $\eta^2 = 0.000$		$F_{1,2030} = 2.71$, $\eta^2 = 0.001$		$F_{1,2030} = 0.51$, $\eta^2 = 0.000$		$F_{1,2030} = 0.73$, $\eta^2 = .000$	
Body concept (2061)[f]	4.15 (0.88)	3.97 (0.92)	4.11 (0.91)	4.00 (0.90)	4.01 (0.90)	4.10 (0.91)	4.04 (0.92)	4.04 (0.90)
	$F_{1,2031} = 0.14$, $\eta^2 = .000$		$F_{1,2031} = 2.33$, $\eta^2 = .001$		$F_{1,2031} = 0.33$, $\eta^2 = .000$		$F_{1,2031} = 2.82$, $\eta^2 = 0.001$	
Plans (1482)[g]	3.50 (0.93)	3.32 (0.95)	3.35 (0.96)	3.45 (0.93)	3.37 (0.94)	3.47 (0.94)	3.35 (0.94)	3.43 (0.94)
	$F_{1,1462} = 2.03$, $\eta^2 = 0.001$		$F_{1,1462} = 4.16$*, $\eta^2 = 0.003$		$F_{1,1462} = 2.27$, $\eta^2 = 0.002$		$F_{1,1462} = 3.77$, $\eta^2 = 0.003$	
Intrinsic motivation (1484)[h]	4.59 (1.08)	4.44 (0.96)	4.62 (0.97)	4.42 (1.05)	4.43 (1.00)	4.61 (1.04)	4.47 (1.01)	4.52 (1.03)
	$F_{1,1464} = 7.45$**, $\eta^2 = .005$		$F_{1,1464} = 14.99$***, $\eta^2 = .010$		$F_{1,1464} = 1.14$, $\eta^2 = .001$		$F_{1,1464} = .005$, $\eta^2 = .000$	
Assessment of activity situation (1482)[i]	3.20 (1.28)	3.59 (1.05)	3.42 (1.16)	3.38 (1.19)	3.49 (1.15)	3.28 (1.21)	3.22 (1.29)	3.49 (1.11)
	$F_{1,1462} = 39.07$***, $\eta^2 = 0.026$		$F_{1,1462} = 0.01$, $\eta^2 = 0.000$		$F_{1,1462} = 3.16$, $\eta^2 = 0.002$		$F_{1,1462} = 3.92$*, $\eta^2 = 0.003$	
Activity emotions (1258)[j]	4.94 (0.86)	4.43 (0.96)	4.70 (0.93)	4.66 (0.96)	4.59 (0.96)	4.81 (0.91)	4.73 (0.95)	4.66 (0.95)
	$F_{1,1243} = 55.2$***, $\eta^2 = 0.043$		$F_{1,1243} = 2.28$, $\eta^2 = 0.002$		$F_{1,1243} = 2.17$, $\eta^2 = 0.002$		$F_{1,1243} = 0.01$, $\eta^2 = 0.000$	
Social support (2064)[k]	2.64 (0.90)	2.90 (0.78)	2.85 (0.82)	2.74 (0.85)	2.83 (0.82)	2.72 (0.87)	2.60 (0.85)	2.89 (0.82)
	$F_{1,2034} = 107.14$***, $\eta^2 = 0.050$		$F_{1,2034} = 0.40$***, $\eta^2 = 0.127$		$F_{1,2034} = 0.24$, $\eta^2 = 0.000$		$F_{1,2034} = 8.15$**, $\eta^2 = 0.004$	

Data are presented as mean (SD).
ANOVA = analysis of variance; M = mean; n_{max} = maximum number; SD = standard deviation.
*$p < 0.05$.
**$p < 0.01$.
***$p < 0.001$.
[a] Indicates missing data.
[b] Barriers is based on a seven-point scale from "not agree at all" (1 point) to "extremely agree" (7 points).
[c] Self-efficacy is based on a five-point scale from "not at all confident" (1 point) to "extremely confident" (5 points).
[d] Outcome expectations is based on a seven-point scale from "not true at all" (1 point) to "extremely true" (7 points).
[e] Affective attitude is based on a seven-point scale from "not true at all" (1 point) to "extremely true" (7 points).
[f] Body concept is based on a seven-point scale from "not true at all" (1 point) to "exactly true" (7 points).
[g] Plans is based on a five-point scale from "not at all true" (1) to "exactly true" (5 points).
[h] Intrinsic motivation is based on a six-point scale from "not true at all" (1) to "exactly true" (6 points).
[i] Assessment of activity situation is based on a six-point scale from "not at all important" (1) to "extremely important" (6 points).
[j] Activity emotions is based on a six-point scale from "not at all important" (1) to "extremely important" (6 points).
[k] Social support is based on a five-point scale from "never" (1) to "very often" (5 points).

Table 7
The mean and standard deviation (in parentheses) of psychosocial correlates across stages and the results of group comparisons ($n = 1267–2071$).[f]

Physical activity stage Psychosocial Correlates (n)	Not Considering ($n_{max} = 218$)	Considering ($n_{max} = 370$)	Preparing ($n_{max} = 214$)	Exploring ($n_{max} = 215$)	Fluctuating ($n_{max} = 365$)	Maintaining ($n_{max} = 690$)	
Barriers (2069)[g]	3.70[a] (1.12)	3.43[b] (0.89)	3.31[b] (1.01)	2.44[c] (0.85)	2.60[d] (0.82)	1.97[e] (0.81)	$F_{5,2063} = 223.51$***, $\eta^2 = 0.351$
Self-efficacy (2066)[h]	2.41[a] (0.76)	2.60[b] (0.64)	2.75[c] (0.70)	3.06[d] (0.70)	3.07[d] (0.70)	3.52[e] (0.79)	$F_{5,2060} = 124.80$***, $\eta^2 = 0.232$
Outcome expectations (2069)[i]	4.15[a] (1.22)	4.46[b] (1.16)	4.67[c] (1.21)	4.59[b,c] (1.08)	4.68[c] (1.10)	4.77[c] (1.12)	$F_{5,2063} = 14.94$***, $\eta^2 = 0.035$
Affective attitude (2071)[j]	4.08[a] (1.48)	4.56[b] (1.39)	4.93[c] (1.39)	5.43[d] (1.24)	5.30[d] (1.22)	5.72[e] (1.23)	$F_{5,2065} = 74.31$***, $\eta^2 = 0.152$
Body concept (2061)[k]	3.80[a] (1.01)	3.68[a] (0.90)	3.81[a] (0.91)	4.03[b] (0.79)	4.08[b] (0.85)	4.37[c] (0.82)	$F_{5,2055} = 38.46$***, $\eta^2 = 0.086$
Plans (1491)[l]	—	—	3.40[a] (0.87)	3.32[a] (0.86)	3.13[b] (0.96)	3.58[c] (0.94)	$F_{3,1487} = 20.38$***, $\eta^2 = 0.039$
Intrinsic motivation (1493)[m]	—	—	3.96[a] (1.04)	4.28[b] (0.95)	4.21[b] (0.96)	4.91[c] (0.91)	$F_{3,1489} = 81.14$***, $\eta^2 = 0.141$
Assessment of activity situation (1491)[n]	—	—	3.43 (1.20)	3.42 (1.16)	3.26 (1.11)	3.46 (1.21)	$F_{3,1487} = 2.26$ (ns)
Activity emotions (1267)[o]	—	—	—	4.51[a] (0.94)	4.41[a] (0.96)	4.88[b] (0.89)	$F_{2,1264} = 36.22$***, $\eta^2 = 0.054$
Social support (2064)[p]	2.21[a] (0.81)	2.47[b] (0.74)	2.76[c] (0.74)	2.93[d] (0.79)	2.88[c,d] (0.76)	3.06[e] (0.84)	$F_{5,2058} = 54.14$***, $\eta^2 = 0.116$

Data are presented as mean (SD).
M = mean; n_{max} = maximum number; SD = standard deviation; — , data not available.
***$p < 0.001$.
[a,b,c,d,e] Indicates a significant difference between the subgroups (Duncan test).
[f] Indicates missing data.
[g] Barriers is based on a seven-point scale from "not agree at all" (1 point) to "extremely agree" (7 points).
[h] Self-efficacy is based on a five-point scale from "not at all confident" (1 point) to "extremely confident" (5 points).
[i] Outcome expectations is based on a seven-point scale from "not true at all" (1 point) to "extremely true" (7 points).
[j] Affective attitude is based on a seven-point scale from "not true at all" (1 point) to "extremely true" (7 points).
[k] Body concept is based on a seven-point scale from "not true at all" (1 point) to "exactly true" (7 points).
[l] Plans is based on a five-point scale from "not at all true" (1) to "exactly true" (5 points).
[m] Intrinsic motivation is based on a six-point scale from "not true at all" (1) to "exactly true" (6 points).
[n] Assessment of activity situation is based on a six-point scale from "not at all important" (1) to "extremely important" (6 points).
[o] Activity emotions is based on a six-point scale from "not at all important" (1) to "extremely important" (6 points).
[p] Social support is based on a five-point scale from "never" (1) to "very often" (5 points).

German and Chinese adults perceived fewer physical complaints from the inactive stages to the active stages, but the Chinese adults had more complaints from the "exploring" stage to the "fluctuating" stage. The German BMI index decreased as the stages increased, whereas an inverse pattern occurred for Chinese participants.

In addition, gender and the stage of change had significant interaction effects on positive subjective wellbeing ($F_{5, 2038} = 2.25$; $p = 0.047$; $\eta^2 = 0.005$) and health satisfaction ($F_{5, 2038} = 2.62$; $p = 0.023$; $\eta^2 = 0.006$). The descriptive values show that the adults of both genders perceived more positive subjective wellbeing with increasing stage, but the positive wellbeing gain was higher for males from the "fluctuating" stage to the "maintaining" stage. The male health satisfaction increased from the "considering" stage to the "maintaining" stage, whereas the females perceived increasing health satisfaction only at the active stages.

There was also a significant interaction effect on the BMI between the education level and the stage of change ($F_{5, 2019} = 2.56$; $p = 0.026$; $\eta^2 = 0.006$). From the "not considering" to the "considering" stages, the BMI for adults with a low education level decreased, but increased for adults with a high education level.

Psychosocial correlates across sociodemographic variables and stages of change: research question 3

Tables 6 and 7 present the results of the group comparisons between nationality, gender, age group, education level, and the six PA stages of behavior change in relation to psychosocial correlates.

The results from ANOVA (Table 6) reveal that nationality had significant main effects on six of 10 psychosocial correlates. Compared with Chinese adults, the German adults had higher PA self-efficacy and stronger intrinsic motivation; perceived more activity emotions but fewer outcome expectations and less social support; and placed less importance on the PA situation.

Gender moreover had significant main effects on five of 10 psychosocial correlates. In comparison to females, males had higher PA self-efficacy and stronger intrinsic motivation;

perceived fewer barriers to PA and greater social support, and made fewer plans for engaging in PA.

A main effect in the age group occurred only for outcome expectations. Compared to older adults, young adults had higher outcome expectations for PA participation.

Significant main effects for the education level were found for two of 10 psychosocial correlates. Adults with a higher education level perceived more social support for PA and placed more importance on activity situation than those with a lower level of education.

The results from ANOVA (Table 7) indicated significant main effects of the PA stage on all psychosocial correlates, except for the assessment of the activity situation. Adults at the "not considering" stage had the lowest values in self-efficacy, outcome expectations, affective attitude, body concept, and social support; however, adults at the "maintaining" stage had the highest scores for these psychosocial correlates. The trend for the barriers score was the opposite of this notion. The effect sizes (η^2) were strong for the association between each physical activity stage and barriers, self-efficacy, affective attitude, intrinsic motivation, and social support; medium for the association between each physical activity stage and body concept and between each physical activity stage and activity emotions; and small for the association between each PA stage and plans and between each PA stage and outcome expectations.

Post hoc tests between adjacent stages revealed that, compared to adults at the "not considering" stage, adults who were at the "considering" stage had lower barriers, higher self-efficacy, more positive outcome expectations, higher affective attitude, and a stronger social support. Adults at the "preparing" stage had higher self-efficacy, more positive outcome expectations, higher affective attitude, and more social support, compared to adults at the "considering" stage. Compared to adults at the "exploring" or "fluctuating" stage, adults at the "preparing" stage perceived greater barriers, lower self-efficacy, more negative affective attitude, lower body concept, and lower intrinsic motivation; however, adults at the "preparing" stage had higher scores for planning PA.

Compared to adults at the "exploring" stage or "fluctuating" stage, adults at the "maintaining" stage demonstrated more positive and higher level scores in eight of 10 psychosocial correlates (except for outcome expectation and assessment of activity situation).

The results of the analysis of interaction effects between the stages of change and sociodemographic variables revealed significant interaction effects for activity barriers between the stages and nationality ($F_{5,\ 2028} = 5.37$; $p = 0.000$; $\eta^2 = 0.013$); self-efficacy ($F_{5,\ 2025} = 16.86$; $p = 0.000$; $\eta^2 = 0.040$), affective attitude ($F_{5,\ 2030} = 3.52$; $p = 0.004$; $\eta^2 = 0.009$), intrinsic motivation ($F_{3,\ 1464} = 18.44$; $p = 0.000$; $\eta^2 = 0.036$), and assessment of activity situation ($F_{3,\ 1462} = 2.64$; $p = 0.048$; $\eta^2 = 0.005$). The descriptive values show that adults in both countries perceived fewer activity barriers as the stage increased. The reduction of perceived barriers was higher for German adults from the "preparing" to the "exploring" stages and from the "fluctuating" to the "maintaining" stages. Adults in both countries also had higher PA self-efficacy as the stage increased, whereas the increase in the self-efficacy mean scores was higher for German adults from the "considering" to the "maintaining" stages.

The German and Chinese adults had higher affective attitudes to PA as the stage increased; however, the increase in the attitude mean scores was higher for the German adults from the "preparing" to the "exploring" stages and from the "fluctuating" to the "maintaining" stages. The Chinese participants had higher intrinsic motivation as the stage increased, whereas this pattern for German participants occurred only from the "fluctuating" to the "maintaining" stages. Adults from both countries moreover placed more importance on the activity situation in the "fluctuating" to the "maintaining" stages, but the increase in the importance mean scores was higher for the German adults.

In addition, gender and the stage of change had significant interaction effects on body concept ($F_{5,\ 2031} = 2.41$; $p = 0.034$; $\eta^2 = 0.006$) and on the assessment of the activity situation ($F_{3,\ 1462} = 2.95$; $p = 0.032$; $\eta^2 = 0.006$). Descriptive values show that males had a higher body concept as the stage increased, whereas females only had this pattern from the "considering" to the "preparing" stages, and from the "fluctuating" to the "maintaining" stages. For the assessment of activity situation, males and females both placed less importance on the activity situation from the "exploring" to the "fluctuating" stages, but the decline in importance indicated that the scores were higher for females.

There was also a significant interaction effect between the age groups and the stage of change for activity barriers ($F_{5,\ 2028} = 2.48$; $p = 0.030$; $\eta^2 = 0.006$). Adults in both age groups perceived lower activity barriers as the stage increased, but the decline in perceived barriers indicated that the scores were higher for younger adults from the "not considering" to the "considering" stages and higher for older adults from the "fluctuating" to the "maintaining" stages.

Discussion

The analyses presented in this paper were based on data collected as part of a collaboration project between Germany and China. The project is called the "Health Enhancing Physical Activity as Health Behavior and Health Resource: Stages, Determinants and Effects." In total, 2071 adults (58% Chinese and 57% females) who were 27–55 years old formed the database for the analyses. This study preliminarily examined three functions of the FIT model in sequences. These are the functions of description, diagnosis, and intervention.

The FIT model as an instrument for describing distinctive stages of physical activity behavior

This study examined the validity of stage assessment of the FIT model by testing the association between the PA stages and energy consumption per week, which complemented research question 1. The PA stages have a strong relationship with energy consumption per week (i.e., daily life activity,

sports, and exercise activity). The amount of explained variance of energy consumption per week by stage was 51.2%. Energy consumption per week moreover did not discriminate between the "not considering" and "considering" stages or between the "considering" and "preparing" stages, but it did discriminate between the "preparing" and "exploring" stages and between the "exploring" and "maintaining" stages. In addition, as the stage progressed from low to high, the average energy consumption per week also increased at each corresponding stage. These findings are consistent with studies by Plotnikoff et al[38] and by Lippke et al[39] regarding planned pair comparisons of PA between adjacent stages.

Based on the findings of this study, future research may study two particular aspects more closely: (1) sedentary behavior does not necessarily mean total inactivity, and therefore it may be reasonable to integrate this more clearly into the stage algorithm; (2) the threshold of 800 kcal per week is a low criterion and only effective for adults who are sedentary for a long time.[8] Therefore, it may be more appropriate to use a higher HEPA threshold such as 1000 kcal per week. The latter value would more closely complement current international PA recommendations. A stage algorithm must be adapted in future studies for different populations (e.g., children, adolescents, young adults, and old adults).

With respect to health correlates and stages of change (i.e., research question 2), all five health correlates significantly differed between the stages. Regarding the relationship between the stages of change and psychosocial correlates (i.e., research question 3), nine out of 10 psychosocial correlates significantly discriminated between the stages of change, except for the assessment of activity situation. This is the first time that this discrimination has been demonstrated in regard to health correlates; the psychosocial correlate results are in line with earlier findings.[25] The findings in this paper overall support the validity of the stage assessment of the FIT model.

The FIT model as an instrument for diagnosis

In regard to research question 3, the five health correlates significantly differed between stages. The amount of variance explained by the PA stages was between 1% and 18%. In particular, health resources, fitness, and health satisfaction had the strongest association with the PA stages. By contrast, there was minimal explained variance in health deficits, negative subjective well-being, and risk factors (e.g., BMI). These findings are consistent with previous PA studies of adolescents and adults.[1,8,40] These studies show that the amount and the intensity of PA improves physiological and psychosomatic health resources. Thus, PA may aid in the prevention of, and the ability to cope with, physiological and psychosomatic health deficits.[40] However, current study also found that weak links were maintained between the PA stages and all health correlates (i.e., effect sizes less than 0.25)—particularly for the health deficits.[41] A possible explanation for the weak relationships in the present study may be the relatively low prevalence of health impairments in the current sample. Thus, the current sample was nonrepresentative of the German and Chinese populations.[42,43]

Further *post hoc* tests revealed that, compared to individuals at lower stages, the individuals at higher stages of the FIT model had better fitness, more positive subjective well-being, less negative subjective well-being, higher health satisfaction, and less physical complaints. Adults in the "fluctuating" stage can be significantly differentiated from the adults in the inactive stages and in the "maintaining" stage, but not significantly differentiated with respect to the "exploring" stage.

German adults rated fitness, health satisfaction, and positive subjective wellbeing, and (paradoxically) negative subjective wellbeing higher than the Chinese adults rated these factors. One explanation could be a general higher sensitivity of German people to emotional and physical states. The most important interaction at the active stages was the higher fitness gain for the German participants, compared to the Chinese participants. This could be an indication of the high engagement of German adults in structured fitness activities.[8] In accordance with previous findings, the German BMI index decreased as the stage increased, whereas the inverse pattern existed for the Chinese adults. Because the average BMI is significantly lower for the Chinese sample, this finding could have been an effect of training—the German adults may be losing fat, whereas the Chinese adults may be building muscle. Because of the low effect sizes, there were no further notable main effects for age, gender, and education. The exceptions are BMI and fitness, which are unsurprisingly higher for males than for females.

In general, these results strengthen the notion that adults possess more health resources and fewer health deficits as their PA stage increases. Therefore, this may imply that once an individual has been classified at a PA stage, it may accordingly be possible to diagnose the status of their health resources and deficits. However, this assumption requires further detailed analysis in the future.

The FIT model as an instrument for planning interventions

The most important function of a PA stage model is to provide intervention guidance for PA promotion. Identifying factors associated with different levels of PA is an important precondition for the planning of interventions in health promotion. This area is referred to as the study of "correlates", "determinants", or "mediators" of PA.[43,44] Based on this idea, the present study has preliminarily examined the association between the stages of PA and selected psychosocial correlates in adults.

In response to research question 3, the current study found that nine psychosocial correlates (i.e., mediators) significantly discriminated between the stages of change, except for the assessment of the activity situation. A consistent pattern of results was revealed, which was generally consistent with previous research.[18,21,23,45] ANOVA with supplementary *post hoc* analyses showed a pattern of increasing mean scores in

eight of nine psychosocial correlates across the stages of change, and showed a decreasing pattern in barriers.

Barriers had the strongest (i.e., negative) associations with the stages of change ($\eta^2 = 0.351$). There was a strong positive association for self-efficacy ($\eta^2 = 0.232$), affective attitude ($\eta^2 = .152$), intrinsic motivation ($\eta^2 = 0.141$), and social support ($\eta^2 = 0.116$). This finding supports former research.[25,34,46,47] The association for outcome expectations and body concept were weaker. The association for plans is weak and inconsistent. The data overall seem to be in line with the notion that cognitive rationality may be overestimated as a factor in the transition process.[48]

Activity emotions are significantly associated with the active stages, but did not significantly discriminate between the stage transitions. Activity emotions are correlates for the maintenance of active behavior, but are not stage-specific *per se*.[24]

Some psychosocial correlates that discriminate between adjacent stages may be considered key mediators when conducting an intervention. In particular, interventions aimed at moving an adult from the "not considering" stage to the "considering" stage may be more successful if the interventions: (1) reduce the adult's perceived obstacles for initiating PA; (2) foster the development of a positive attitude towards PA; (3) increase support; and (4) enhance an adult's confidence (e.g., through self-determination) in being able to initiate PA. The current findings further indicate that for the progression of adults from the "considering" stage to the "preparing" stage, interventions should include strategies aimed at further developing more positive affective attitudes towards PA participation and fostering support. To help facilitate progression from the "preparing" stage to the "exploring" stage, it may be particularly important to increase an adult's self-efficacy for accomplishing planned PA, to foster more support, and to decrease perceived barriers to PA participation. To encourage the progression from the "exploring" stage to the "maintaining" stage, intervention strategies may need to focus on enhancing intrinsic motivation and confidence to continue with PA, and further decrease perceived barriers for PA.

The present findings indicate that individuals at the "fluctuating" stage are at higher risk for disengagement, compared to individuals at the "maintaining" stage or the "exploring" stage. For individuals at the "fluctuating" stage, interventions should include strategies that target reducing the perceived barriers (so as to limit attrition); increasing the intrinsic motivation to maintain PA; and encouraging the development of plans for PA.

In regard to the main effects of nationality on the psychosocial correlates, emotional correlates (i.e., intrinsic motivation and activity emotion) are central factors that foster PA in German participants, whereas cognitive and social correlates (i.e., outcome expectations and social support) are more important for Chinese participants. Having fun during PA is obviously of greater importance in Germany than in China. These results furthermore also reflect the high meaning of social influence in the Chinese society. Social support is surprisingly higher for men than for women. This is contrary to studies that have found that social support is a very important resource that foster physical activity in women (e.g., Fuchs 1997).[48] There were no further notable main effects for gender, age, and education because of the small effect sizes. In regard to the interaction effects, the results show that gains in psychosocial correlates are stronger for the German participants than for the Chinese participants. These findings support the notion that a stage-based intervention needs to be highly complex and requires more than one level of development. This challenge has not yet been met.[13,44]

Limitations

There are several limitations to the present study. First, the cross-sectional design did not provide the strongest evidence for causal relationships. Thus, future longitudinal and intervention studies need to be conducted to investigate the different roles of psychosocial correlates on different PA stages. Second, the reliance on the participants' self-report of PA may be another limitation. The measures of PA behavior employed in this study are already well validated; however, it would be desirable to examine PA behavior objectively for an improved validation of the stage assessment. Third, the current study results were all based on data from adult samples in Germany and in China. The validity of the FIT model should be tested with other samples in future studies.

Perspective

The results of this study showed the potential usefulness of the FIT model in the PA promotion domain. Using a stage algorithm can appropriately classify the adult's stage of change. Based on the close association between the stage of change and the health correlates in the FIT model, it may be possible to further diagnose how well an adult's health may be in relation to fitness, subjective well-being, health satisfaction, and physical complaints.

This study has identified several psychosocial correlates that may be important to target for change by means of stage-matched interventions to help inactive adults become more physically active and to help active adults maintain their HEPA level. The results further indicated that strategies aimed at targeting psychosocial factors to facilitate an individual's progression through the stages of change may be somewhat different, especially in regard to nationality and gender.

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