Chapter 3
Promotion of Strength Training

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Abstract The health benefits of strength training have been well established by numerous intervention studies. Based on such studies, current physical activity guidelines recommend strength training to improve public health. However, previous reviews have not focused on the behavioral aspects of strength training. Thus, this chapter briefly reviews research trends in the prevalence and correlates of strength training, and interventions to promote strength-training behavior. Previous studies have reported 3.9–21 % of the populations in each country engage in strength-training behavior. Recent studies have begun to reveal the environmental correlates of strength-training behavior (e.g., access to strength-training facilities), as well as socio-demographic and psychosocial correlates (e.g., age, perceived health benefits, and barriers to participation). Although a community-wide campaign has been reported, intervention studies to promote strength-training behavior are limited. Further well-designed observational studies examining correlates of strength-training behavior and large-scale intervention trials are warranted to confirm effective strategies to promote strength-training behavior.

Keywords Strength training • Behavioral research • Behavior mechanisms • Environment design • Health promotion

3.1 Introduction

An increasing number of studies have shown that strength training (generally described as exercises designed to enhance muscle strength and endurance) provides numerous health benefits. Based on such studies, meta-analyses have revealed that strength training is an effective way to reduce blood pressure (Cornelissen et al.

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2011), lipids and lipoproteins (Kelley and Kelley 2009), metabolic syndrome (Strasser et al. 2010), postmenopausal bone loss (James and Carroll 2006), and physical disability (Liu and Latham 2011). Thus, in addition to aerobic activities, current physical activity guidelines and national policies recommend strength training for public health. Table 3.1 presents a summary of strength-training recommendations. Each country represented in this table (the United States [US Department of Health and Human Services 2008, 2009], Australia [Brown et al. 2005], Canada [Public Health Agency of Canada 1998], the United Kingdom [O'Donovan et al. 2010]), and the World Health Organization (2010) recommend strength training (at least twice a week) to improve the health of populations around the globe.

While the health benefits of strength training are well established and strength training is recommended for public health, strategies that can be used to successfully promote strength training have not been clarified in previous studies. To elucidate them, behavioral epidemiology is a useful framework (Sallis et al. 2000). A behavioral epidemiology framework (Sallis et al. 2000) discriminates health promotion studies into five phases. Phase 1 establishes links between behaviors and health outcomes, phase 2 develops measures of the behavior and examines prevalence of the behavior, phase 3 identifies correlates of the behavior, phase 4 develops and evaluates interventions to change the behavior, and phase 5 translates research into practice. Following this framework (Sallis et al. 2000), some review articles

Table 3.1 Strength training recommendations for public health

Name and year	Title	Target population
Public Health Agency of Canada (1998)	Handbook for Canada's Physical Activity Guide to Healthy Active Living & Handbook to the Guide for Older adults	Adults (<65 years) and older adults (≥65 years)
Australian Government Department of Health and Aging (Brown et al. 2005)	Choose Health: Be Active	Older adults
American College of Sport Medicine/American Heart Association (Haskell et al. 2007 and Nelson et al. 2007)	Physical Activity and Public Health: Updated Recommendation	Adults and older adults
US Department of Health and Human Services (2008)	2008 Physical Activity Guide for Americans	Adults and older adults
American College of Sport Medicine (Chodzko-Zajko et al. 2009)	Exercise and Physical Activity for Older Adults: Position Stand	Older adults
US Department of Health and Human Services (2009)	Healthy People 2020	Adults
British Association of Sport and Exercise Sciences (O'Donovan et al. 2010)	The ABCs of Physical Activity for Health	Adults and older adults
World Health Organization (2010)	Global Recommendations on Physical Activity for Health	Adults and older adults

(Cornelissen et al. 2011; Kelley and Kelley 2009; Strasser et al. 2010; James and Carroll 2006; Liu and Latham 2011) are now available describing phase 1 studies of strength training (i.e., the relationships between strength-training behavior and health outcomes). However, no previous reviews have described the trends in the studies of prevalence, correlates, and intervention strategies of strength-training behavior, which correspond to phases 2, 3, and 4. Review articles have been published for walking behaviors and bicycling (Ogilvie et al. 2007; Panter and Jones 2010; Saelens et al. 2003; Saelens and Handy 2008; Yang et al. 2010); such reviews will be essential to guide research about and the promotion of healthy strength training.

Thus, this section briefly reviews research trends in (1) prevalence of strength-training behavior, (2) correlates of strength-training behavior, and (3) interventions to promote strength-training behavior.

3.2 Prevalence of Strength-Training Behavior

Table 3.2 presents the prevalence of strength-training behavior reported in previous studies. As shown in Table 3.2, the definitions of strength training and target populations varied by studies. However, previous studies have reported the prevalence of strength-training behavior as being from 3.9 % to 21 % of the populations in each country (Chevan 2008; Galuska et al. 2002; Harada et al. 2008a, b; Humphries et al. 2010; Kruger et al. 2004, 2006; Morrow et al. 2011). Healthy People 2020, a health promotion plan in the United States, set a goal of elevating the percentage of those who perform regular strength training to 30 % of the entire population by 2020 (US Department of Health and Human Services 2009).

We reported the prevalence of strength-training behavior in Japan in 2 studies (Harada et al. 2008a, b). The first study (Harada et al. 2008a) was a secondary analysis of the 2006 SSF National Sports-Life Survey (Sasakawa Sport Foundation 2006). This survey is a high-quality cross-sectional survey assessing participation in sports, exercises, and physical activities in Japan. The analysis revealed that the prevalence of strength training on 2 days or more per week was 3.9 %, and that the prevalence was lower in older individuals (2.5 % for those 60–69 years old, 0.6 % for those over 70 years old). However, the 2006 SSF National Sports-Life Survey did not give a specific definition for strength training.

We defined strength training as all exercises intended to enhance muscle strength and endurance, and conducted a web-based questionnaire survey of 5,177 people (Harada et al. 2008b). We found that 14.4 % of respondents engaged in strength training on 2 or more days per week, while 39.5 % of them did not intend to engage in any strength training at all. Furthermore, Harada et al. (2008b) also revealed that the most common types of strength training were done at home (74.3 %), used the participant's own body weight (60.4 %), and were done without special lectures (85.1 %).

Table 3.2 Prevalence of strength training

Study	Target population	Term and definition	Prevalence
Chevan (2008)	American adults (≥18 years, *n* = 29,783)	Strength training: physical activities specifically designed to strengthen muscles, such as lifting weights or doing calisthenics	21 % (≥2 days/week)
Galuska et al. (2002)	American adults (≥18 years, *n* = 16,697)	Resistance training: lifting weight	13.4 % (≥1 day/month) 8.7 % (≥2 days/week)
Harada et al. (2008a)	Japanese Adults (≥20 years, *n* = 1,867)	Strength training: no definitions	3.9 % (≥2 days/week)
Harada et al. (2008b)	Japanese Adults (≥20 years, *n* = 5,177)	Strength training: all exercises intended for enhancing muscle strength and endurance	14.4 % (≥2 days/week)
Humphries et al. (2010)	Australian adults (≥18 years, *n* = 1,230)	Resistance training: gym-based resistance training	13.7 % (≥1 day/week)
Kruger et al. (2004)	American older adults (≥65 years, *n* = 5,537)	Strength training: physical activities specifically designed to strengthen muscles, such as lifting weights or doing calisthenics	11 % (≥2 days/week)
Kruger et al. (2006)	American adults (≥18 years, *n* = 30,801 to 33,326)	Strength training: physical activities specifically designed to strengthen muscles, such as lifting weights or doing calisthenics	17.7–19.6 % (≥2 days/week)
Morrow et al. (2011)	American women adults (unavailable for age range, *n* = 918)	Muscle strengthening activity: activities to increase muscle strength or tone, such as lifting weights, using weight machines, using exercise bands or doing pull-ups or sit-ups	15 % (≥2 days/week)

3.3 Correlates of Strength-Training Behavior

3.3.1 Socio-demographic Correlates of Strength-Training Behavior

Information about socio-demographic correlates of physical activity is necessary to enable us to decide who should be targeted for promotions of physical activity. Table 3.3 presents socio-demographic correlates reported in previous studies (Chevan 2008; Galuska et al. 2002; Harada et al. 2008a, b; Humphries et al. 2010; Kruger et al. 2004, 2006). Overall, 11 factors are reported as socio-demographic correlates of strength-training behavior; gender, age, educational level, self-rated

Table 3.3 Socio-demographic correlates of strength training

Factor	Significant association	Non-significant association
Gender (male)	Chevan (2008), Galuska et al. (2002), Harada et al. (2008a, b), Kruger et al. (2004, 2006)	Humphries et al. (2010)
Age (younger)	Chevan (2008), Galuska et al. (2002), Harada et al. (2008a, b), Humphries et al. (2010), Kruger et al. (2006)	Kruger et al. (2004)
Educational level (high)	Chevan (2008), Galuska et al. (2002), Harada et al. (2008b), Kruger et al. (2006)	Humphries et al. (2010)
Self-rated health (good)	Galuska et al. (2002), Humphries et al. (2010), Kruger et al. (2004)	Harada et al. (2008a)
Marital status (single)	Chevan (2008), Harada et al. (2008b)	Harada et al. (2008a), Kruger et al. (2004)
Body mass index (normal)	Galuska et al. (2002), Kruger et al. (2006)	Harada et al. (2008b)
Ethnicity (white)	Kruger et al. (2004, 2006)	Chevan (2008), Galuska et al. (2002)
Income level (high)	Harada et al. (2008b)	Humphries et al. (2010)
Full-time job (yes)	Harada et al. (2008b)	
Smoking status (no)	Harada et al. (2008a)	
Self-rated fitness (good)	Harada et al. (2008a)	
Sedentary Behavior		Harada et al. (2008b)

health, marital status, body mass index, ethnicity, income level, full-time job, smoking status, and self-rated fitness. Among them, gender, age, and educational level have been repeatedly indicated as the correlates of strength training in previous studies.

In Japan, our two studies (Harada et al. 2008a, b) examined socio-demographic correlates of strength-training behavior. Harada et al. (2008a) revealed that gender, age, smoking status, and self-rated fitness are associated with strength training, but self-rated health and marital status are not significantly associated with strength training in the Japanese population. Furthermore, Harada et al. (2008a) indicated that age is the socio-demographic correlate most strongly associated with strength training. Thus, Harada et al. (2008a) suggest that strength-training promotions targeting older people might be needed.

In Harada et al. (2008b), six factors (gender, age, educational level, marital status, income level, and full-time job) were identified as socio-demographic correlates of strength training behavior. Although the influence of marital status differs from that found in Harada et al. (2008a), Harada et al. (2008b) also suggested the importance of strength-training promotions targeting older people.

3.3.2 *Psychosocial Correlates of Strength-Training Behavior*

The identification of modifiable factors associated with physical activity is recognized as an essential phase in the development of effective promotion strategies. Numerous studies have examined psychosocial correlates of physical activity. Furthermore, as shown in Table 3.4, recent studies have begun to reveal psychosocial factors associated with strength-training behavior. Six studies showed that the self-efficacy/perceived behavioral control (one's beliefs about their capabilities to maintain strength-training behavior) is positively correlated with strength-training behavior (Bopp et al. 2006; Bryan and Rocheleau 2002; Cardinal and Kosma 2004;

Table 3.4 Psychosocial correlates of strength training

Factor	Significant association	Non-significant association
Self-efficacy/perceived behavioral control	Bopp et al. (2006), Bryan and Rocheleau (2002), Cardinal and Kosma (2004), Cardinal et al. (2006), Harada et al. (2008b), Rhodes et al. (2007)	Dean et al. (2007), Plotnikoff et al. (2008)
Behavioral intention	Bryan and Rocheleau (2002), Dean et al. (2007), Rhodes et al. (2007)	Plotnikoff et al. (2008)
Perceived benefits/pros	Bopp et al. (2004), Cardinal et al. (2006), Harada et al. (2014b)	
Perceived barriers/cons	Bopp et al. (2004), Cardinal et al. (2006), Harada et al. (2014b)	
Attitude		Dean et al. (2007), Plotnikoff et al. (2008), Rhodes et al. (2007)
Subjective norm		Dean et al. (2007), Plotnikoff et al. (2008), Rhodes et al. (2007)
Social support	Bopp et al. (2004)	Bopp et al. (2006)
Enjoyment	Bopp et al. (2006)	
Process of change	Cardinal and Kosma (2004)	
Information from interpersonal channels (friends, health care provider)	Harada et al. (in press)	
Information from the Internet	Harada et al. (in press)	
Information from print media (book)	Harada et al. (in press)	
Information from mass media		Harada et al. (in press)
Depression		Bopp et al. (2004)
Perceived stress		Bopp et al. (2004)
Personality (extroversion)		Bryan and Rocheleau (2002)

Cardinal et al. 2006; Harada et al. 2008b; Rhodes et al. 2007). Moreover, behavioral intention (Bryan and Rocheleau 2002; Dean et al. 2007; Rhodes et al. 2007), social support (Bopp et al. 2004), enjoyment (Bopp et al. 2006), and the processes of change (a concept of the transtheoretical model [Prochaska and DiClemente 1983]: Cardinal and Kosma 2004) are reported as psychosocial correlates of strength-training behavior.

We have reported the results of two studies about psychosocial correlates of strength-training behavior (Harada et al. 2014b; Harada et al. in press). Although previous studies have examined associations between perceived benefits of and barriers to strength training (Bopp et al. 2004; Cardinal et al. 2006), they have not focused on using these associations to create strength-training recommendations for older people. Thus, Harada et al. (2014b) developed perceived health benefit-and-barrier scales based on current strength-training recommendations for older people, and examined associations of perceived health benefits and barriers to strength training with the stages of change for strength-training behavior (a concept of the transtheoretical model [Prochaska and DiClemente 1983]: precontemplation, contemplation, preparation, action, and maintenance stages) among older Japanese people. A cross-sectional questionnaire was distributed through the mail to 2,092 individuals aged 60–74 years living in Tokorozawa city, and 1,244 of them returned questionnaires. The results, after adjusting for demographic variables, showed that both the perceived health-benefit and the barrier scores were significantly associated with the stages of change for strength-training behavior described above. Based on these findings, Harada et al. (2014b) suggest that information about the health benefits of strength training for older adults and about the recommended type of strength training for this population might help to develop strategies to promote strength training among older people.

Our second study (Harada et al. in submission) explored what makes a communication channel an effective way to provide strength-training information. To develop successful communication strategies promoting strength-training behavior among older people, identification of effective communication channels for providing information is necessary. However, no studies have examined associations of information sources with strength-training behavior. Thus Harada et al. (in press) examined which information sources about strength training are associated with strength-training behavior among older Japanese adults. In this study, we analyzed the same data as Harada et al. (2014b). The results showed that strength-training information from healthcare providers, friends, books, and the Internet were positively correlated with regular strength-training behavior. This result suggests that providing strength-training information from these sources would be an effective way to promote strength-training behaviors among older adults. In contrast, this study did not find significant relationships between information from mass media and strength-training behavior. According to our result, providing information by mass media is an ineffective way to change strength-training behavior at the population level.

3.3.3 *Environmental Correlates of Strength-Training Behavior*

In terms of an ecological model (Sallis et al. 2006), environmental attributes, which can have long-term effects on large populations, represent an emerging area of research into physical activity and public health. However, except for our studies, only two studies (Bopp et al. 2006; Sallis et al. 1997) have examined environmental correlates of strength-training behavior, and Bopp et al. (2006) did not find significant associations (Table 3.5). A further examination of the relationship between strength-training behavior and environmental factors would provide information useful for exploring the effectiveness of environmental intervention to promote strength training.

Therefore, we investigated the relationship between strength-training behavior and the perceived environment in older Japanese people aged 65–75 (Harada et al. 2011). An Internet-based survey was conducted of 293 older adults. In this survey, we measured two types of environmental factors: environmental factors for general physical activity (11 items, the international physical activity questionnaire environmental module: Inoue et al. 2009), and environmental factors specific to strength training (access to facilities for strength training and home equipment for strength training). In results, regarding the specific environmental factors, both home equipment for strength training and access to facilities for strength training were positively correlated with strength-training behavior. In contrast, only 1 of the 11 general environmental factors was significantly correlated with strength-training behavior. Thus, these results indicate that specific environmental factors will be associated with strength training behavior more strongly than general environmental factors.

Table 3.5 Environmental correlates of strength training

Factor	Significant association	Non-significant association
Home equipment	Harada et al. (2011), Sallis et al. (1997)	
Perceived access to strength-training facilities	Harada et al. (2011, 2014a)	
Seeing active people	Harada et al. (2011)	
Objective access to strength-training facilities		Harada et al. (2014a)
Perceived access to exercise/ recreational facilities		Sallis et al. (1997), Harada et al. (2011)
Environmental barriers		Bopp et al. (2006)
Residential density		Harada et al. (2011)
Presence of sidewalks/bike lanes		Harada et al. (2011)
Perceived access to public transport		Harada et al. (2011)
Perceived access to shops		Harada et al. (2011)
Neighborhood safety (crime, traffic)		Harada et al. (2011)
Aesthetics		Harada et al. (2011)
Household motor vehicles		Harada et al. (2011)

Next, we examined the associations of perceived and objectively-measured access to strength-training facilities with strength-training behavior (Harada et al. 2014a). Because the importance of employing objective assessments (e.g., the use of a geographic information system; see below) has been highlighted in other physical activity studies, employing both self-reported and objective assessments of environmental factors is appropriate if we aim to better understand environmental influences on strength-training behavior. A cross-sectional questionnaire survey targeted 3,000 Japanese adults and 1,051 answered it. Objective access to strength-training facilities (number of facilities within a radius of 1,500 m from the respondent's home) was calculated for each respondent using a geographic information system. Our results showed that perceived good access to exercise facilities, but not objective access to facilities, was significantly associated with strength-training behavior. Thus, Harada et al. (2014a) concluded that perceived access to strength-training facilities may be a stronger predictor of strength-training behavior than objective access to the facilities.

3.4 Interventions to Promote Strength-Training Behavior

Table 3.6 presents summaries of intervention studies designed to promote strength-training behavior. Compared with observational studies (i.e., studies about prevalence and correlates of strength-training behavior), a fewer number of intervention studies have been conducted.

Ferherman et al. (2011) and Shirazi et al. (2007) developed intervention programs based on the transtheoretical model (Prochaska and DiClemente 1983). This model is a commonly-used psychological model of health behaviors and consists of four concepts: stages of change, processes of change, decisional balance, and self-efficacy. Intervention programs were provided to women volunteers recruited from local centers. Ferherman et al. (2011) and Shirazi et al. (2007) showed that intervention groups significantly improved psychological variables (e.g., stages of change and decisional balance) and muscle strength.

Katula et al. (2006) reported the effects of a group-based counseling program. The program was developed based on the empowerment theory (Zimmerman 1995) and the self-efficacy theory (Bandura 1997). Each group consisted of two participants (total $n = 22$ at baseline), and they were educated to provide social support and to enhance each other's self-efficacy. The results showed that the intervention group improved the desire for body strength and the self-efficacy for strength-training.

In Japan, Kamada et al. (2013) reported the effects of a community-wide campaign by a cluster randomized control trial. While three other studies (Fetherman et al. 2011; Katula et al. 2006; Shirazi et al. 2007) targeted voluntary participants and analyzed smaller samples, Kamada et al. (2013) targeted all middle-aged and older people living in Unnan city. Unnan city consists of 32 communities defined by the city government. From the 32 communities, 12 communities were randomly selected and allocated to 1 of 4 groups: control, aerobic activity, flexibility and

Table 3.6 Intervention to promote strength-training behavior

Study	Target population	Allocation of group	Intervention strategy	Duration	Main results
Ferherman et al. (2011)	Older women (≥55 years) recruited from senior centers	Based on access to two local senior centers, participants were allocated into strength training only group ($n=14$) or strength training plus behavior change group ($n=13$)	Counseling using goal-setting worksheet developed by the transtheoretical model constructs (2 times)	12 weeks	Intervention group progressed the stages of change and improved perceived pros, body strength, and body flexibility.
Kamada et al. (2013)	All middle-aged and older adults (40–79 years)	12 communities (randomly sampled from Unnan city) were randomly allocated four groups: control group; aerobic activity group; flexibility and muscle-strengthening activities group; and aerobic, flexibility, and muscle-strengthening activities group	Combination of information, education, and support deliveries developed by social marketing principles	1 year	Intervention group did not show significant improvement in level of physical activity
Katula et al. (2006)	Older adults (≥60 years) recruited by advertisement	Participants were randomly allocated into traditional strength training group ($n=18$) or strength training plus empowerment group ($n=20$)	Group-based counseling (1 time) and pair supports based on empowerment theory and self-efficacy theory (biweekly)	6 weeks	Intervention group improved the desire for body strength and the self-efficacy for strength-training
Shirazi et al. (2007)	Middle-aged women (40–65 years) randomly sampled from the District Health Center	A trial and control center were randomly selected from 39 centers ($n=61$ in the trial center, $n=55$ in the control center)	Education program based on the stages of change and processes of change (2 instructional sessions & print delivery every 2 weeks)	12 weeks	Intervention group progressed stages of change, and improved total physical activity level, muscle strength, and balance ability

muscle-strengthening activities, and aerobic, flexibility, and muscle-strengthening activities. The campaign consisted of three components: information delivery (e.g., flyers, leaflets, community newsletters), education delivery (e.g., education and encouragement by professionals during medical check-ups and community events), and support delivery (e.g., development of social support, and providing pedometers). This program was developed using social-marketing principles (analyzing the situation, segmenting and targeting the market, setting objectives, and developing a marketing strategy). However, although awareness and knowledge levels were significantly higher in the intervention group, the intervention group did not show a significant improvement in the level of physical activity including engagements in strength training.

3.5 Conclusions

In conclusion we briefly review research trends in prevalence, correlates, and intervention strategies of strength-training behavior. Key points of this review include:

1. Previous studies have reported the prevalence of strength-training behavior as 3.9–21 % of the populations in each country.
2. Among socio-demographic factors, gender, age, and educational level have repeatedly been indicated as the correlates of strength training in previous studies.
3. The self-efficacy, behavioral intention, social support, enjoyment, the process of change, perceived benefits and barriers, and sources of strength-training information have been reported as psychosocial correlates of strength-training behavior.
4. Recent studies have begun to reveal environmental correlates of strength-training behavior (e.g., access to strength-training facilities).
5. Although results of a community-wide campaign were reported, intervention studies to promote strength-training behavior are limited.

Compared with studies of walking and bicycling behavior (Ogilvie et al. 2007; Panter and Jones 2010; Saelens et al. 2003; Saelens and Handy 2008; Yang et al. 2010), fewer studies have been conducted to elucidate how to promote the health benefits of strength training. Further well-designed observational studies (e.g., longitudinal examinations measuring both the objective environment and psychosocial factors) designed to examine the correlates of strength-training behavior and large-scale intervention trials are warranted to confirm effective strategies to promote strength-training behavior.

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