Walking Speed, Aging, and Health

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Introduction

While the aging population is increasing rapidly worldwide, one of the predictors to determine an individual's independent living ability and quality of life is walking speed (1). As we age, our walking speed slows down due to decreased strength, muscle torque-velocity, and altered gait mechanics (2). Skeletal muscle mass loss leads to functional impairment, disability and mortality in elderly adults (3). Consequently, this leads to decreased physical activity. Physical inactivity is the 4th leading risk factor for global mortality and its rates are increasing (4). On average, physical capacity decreases 20% per 10 years in adults 70-years and older (5). To combat this decline, we can use knowledge on how environmental factors and human physiology impact walking speed in order to manipulate these variables to increase walking speed and optimize health outcomes. The purpose of this review is to provide insight on how the mechanics of the lower limbs, walking environment, and behavioral factors affect walking speed. A second aim of this review is to discuss how we can manipulate these variables to increase walking speed and prevent mortality and physical degradation.

Physiology

Walking speed affects the lower limb mechanics of the body. Lower limb stiffness and leg stiffness vary based on walking speed (6). Leg stiffness is a reflection of lower limb dynamics whereas joint stiffness is a reflection of musculotendinous stiffness (6). Leg dynamic stiffness decreases as hip and ankle joint stiffness increases (6). Hip and ankle stiffness are positively correlated, and knee and ankle are as well (6). The alternation of decreased leg stiffness, but increased joint stiffness provides a control mechanism for walking (6) by changing how lower limb dynamics and musculotendinous stiffness respond while walking. Understanding how stiffness changes based on walking speed can be used in therapeutic models to target and strengthen certain leg components. For example, the therapist or exercise trainer can measure leg, hip, ankle, and knee stiffness levels. If the joint stiffness levels are not positively correlated or if there is not a decrease in leg stiffness while walking, these are indicators noneffective gait mechanics are performed. The therapist and exercise trainer's exercise regimens can focus on fixing these deviations to ensure proper gait mechanics are used to enhance walking speed.

The knee extensor is an important component in walking as it functions in the center of mass and energy transfer during the push off phase of walking. Humans have a knee extensor reserve of 65% strength capacity (2). This is beneficial because it means that at faster walking speeds and after exercise, healthy adults have a low functional demand of the knee. However, functional demand, which is the ratio between external joint kinetics and maximal muscle torque, is increased in less active older adults compared to young adults (2). As we age, muscle torque may be a limiting factor in functional demand due to adults over the age of 60 years losing up to 3.5% of leg extensor power each year (2). Functional demand is increased with faster walking speeds and post exercise by 2-3%. (2). As the aging population is faced with the disadvantage of greater functional demand of the knee during walking based on their decreased power output, further disadvantages emerge due to the increased functional demand at faster walking speeds and post exercise. Understanding how functional demand varies based on age, walking speed, and throughout exercise can be used to regulate exercise demands throughout the exercise duration. This must be done to ensure that exercise regimens do not place too much stress on the older population's knee extensor which could negatively impact their walking speed. Trainers, therapists, and health professionals need to be aware of the additive effects of knee functional demand while aging to ensure their physical activity suggestions do not lead to greater functional demands that inhibit the gains of increased walking speeds.

Lower limb joint angles and angular velocity are important aspects during walking speed. Angular velocity provides information on how fast the joint is moving during walking and it varies based on the phase of walking (7). Lower limb hip, knee, and ankle joint angles and angular velocities had consistent gait traces at different walking speed, but the angles and angular velocities increased as walking speed increased (7). This means that regardless of walking speed, the hip, knee, and ankle joint angles and angular velocities have a similar pattern. The knee joint has the greatest angular velocity when it's extended during the terminal swing phase of gait whereas the hip and ankle joints have their largest angular velocity during the push off phase (7). Understanding the proper joint angular velocities at various speeds aids in assessing and treating individuals with deviations from the norm (7). Therapists and exercise trainers can measure these locations' angles and angular velocities throughout the different gait phases and walking speeds. If there are different angles and angular velocity patterns found at different walking speeds, this indicates that a deviation from the norm has occurred. Measuring these variables at different walking speeds and where the greatest angular velocities occur provides information of one's gait mechanics. If they do not follow what is expected to optimize walking speed, therapists and exercise trainers will be able to target their exercise regimens to correct the deviation by joint and by walking phase to ensure optimal walking speed can be reached.

Environment

Climate and the surrounding environment of an individuals' walking space affects their speed. As temperature decreases, individuals' walking speed increases (4). This means that individuals will benefit if they walk in colder temperatures because they would walk at faster speeds and prevent the decreases in strength, muscle torque-velocity, and altered gait mechanics that are associated with decreased walking speeds (2). However, if snow covers the ground, individuals' walking speed decreases by 0.102m/s (4). People should avoid walking when snow covers the ground because they increase their risk for decreased strength and improper gait mechanics. Walking in cooler temperature provides a benefit to walking speed as long as the ground is clear of snow. If walkways had covers that could prevent snow from reaching the ground, this would be a benefit for those exercising in colder climates.

Generalizations between walking speed measurements in a laboratory setting and during normal, daily life cannot be made and caution must be applied when interpreting results of laboratory walking speeds. Daily living walking speed is slower than one's speed in a laboratory setting both at maximum and average walking speed measurements (8). If one's daily walking speed standard deviation is less than 0.25 m/s and laboratory normal walking speed is less than <1.41 m/s, they are at risk for pre-frailty (8). These individuals have higher rates of weight loss, weakness, slowness, exhaustion, and low activity (8). These factors lead to increased risk for decreased muscular strength and range of motion which shortens step length. The individuals are at higher risk for stroke and mortality by cognitive decline and inability to perform activities of daily living due to pre-frailty (8). Researchers and those assessing walking speed can use this information to understand that how an individuals' usual walking speed is most likely slower than their recorded measurements. Physicians and trainers can use this information to determine who is at risk for frailty and encourage those at risk to join programs or meet with other health professionals who can help increase these variables and prevent mortality.

Behavior

As technology and diet gain prominence in our society, their effect on walking speed cannot go unnoticed. Healthy eating decreases reductions in skeletal muscle and bone mass and neurodegenerative diseases (5). Since aging leads to decreases in skeletal muscle mass (3), healthy eating can play a preventative role in reversing this effect. Individuals around 60 years old whom increased their healthy eating index, which is a measure of overall diet quality, scores by 10 points had faster walking speeds seven years later in life (5). The authors found that increased walking speeds are associated with diets that included the following foods: greens, beans, whole-grains, seafood, and plant-based proteins (5). The diets with these food components reduced the rates of decreased physical function during the aging process (5). This means that individuals who engaged in healthy eating did not experience the physical degradation brought on by the aging process. The drastic effect healthy eating has on the physical functioning of the body as we age must be prominent in the discussions and evaluations of health care decisions. The increase in walking speed provides promising results in health benefits such as increased muscle and bone mass and neurological function.

During walking, technology requires the individual to add neurological dual task costs such as attentional, cognitive, and perceptual demands during walking. Texting decreases executive function and working memory by placing more cognitive demands on the body (9). Holding a phone during walking alters the individuals' balance and obese individuals also face slower walking gaits compared to healthy weight individuals (9). Compared to healthy weight individuals, obese individuals have longer double support, which is when both feet are on the ground, longer stance time, which is the time between when the foot hits and leaves the ground, and lower turn velocity of their gait mechanics during walking. Decreases in walking speed were due to decreased cadence and stride length (9) which is linked to decreased muscle strength and range of motion and higher risk for stroke and frailty (8). These findings demonstrate that technology negatively impacts an individual's gait mechanics while walking and puts additional strain on the body's neurological and musculature systems. Individuals should consciously make the effort to not text or use technology while walking in order to reduce the strain placed on their body.

Individuals with faster walking speeds have decreased disability risk (10). Disability risk is based on if the individual needs care or support to perform activities of daily living (10). This means that those with faster walking speeds require less support or care performing activities of daily living. Physical activity provides a mediating factor in the relationship between walking speed and mortality (10). This means that those who are physically active have a lower risk of mortality. Individuals of any physical activity level receive the benefit of decreasing their disability risk, but those who are physically active also have the added protection of decreasing their mortality risk. Since physical inactivity is the 4th leading risk factor for global mortality (4), physicians, therapists, and health professionals can use this knowledge to encourage their patients to engage in physical activity to decrease their mortality risk and risk of requiring care or support as they age.

Conclusion

The findings of this review support that walking speed and health have a positive correlation, so that as walking speed improves the risk of mortality is reduced. Levels of stiffness and functional demand of the lower limbs can be used as biomarkers to predict gait mechanics' efficiency and walking speed. This information can be used in the design of therapeutic and exercise regimens to strengthen certain lower limb areas or joints to increase walking speed. Ensuring proper climate is present during walking, eliminating the use of technology while walking, and adding certain food groups to our diet all increase walking speed and improved health. By understanding how human behavior, physiology, and walking environments affect walking speed, we can then incorporate and manipulate these variables to increase the longevity of individuals' quality of life.

Elements

1. **Apply it**
   - Therapists and trainers can design exercise regimens to alter lower limb stiffness, knee extensor functional demand, and joint angles and angular velocities to optimize their client's walking speed in order to reduce mortality risk.
   - Physicians and health-related professionals can discuss with their patients the importance of walking speed in order to promote physical activity and explain how behaviors affect walking speed and their health.
2. **Bridging the Gap**
   - Increased walking speed is correlated with reductions in mortality risk. The physiology of our lower extremities, our walking environment, and our lifestyle behaviors can be used to predict walking speeds and, therefore, overall health. As

health professionals, we can educate our clients on the importance of physical activity and proper walking speed mechanics to promote longevity.

3. **Summary statement**
   - Walking speed is linked to an individual's risk of mortality and environmental factors, behavioral choices, and walking mechanics can be used to predict this risk.
4. **Pulled text**
   - The findings of this review support that walking speed and health have a positive correlation, so that as walking speed improves the risk of mortality is reduced. By understanding how human behavior, physiology, and walking environments affect walking speed, we can then incorporate and manipulate these variables to increase the longevity of individuals' quality of life.

Bio

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