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Personal Training Quarterly (PTQ) publishes basic educational information for Associate and Professional Members of the NSCA specifically focusing on personal trainers and training enthusiasts. As a quarterly publication, this journal's mission is to publish peer-reviewed articles that provide basic, practical information that is research-based and applicable to personal trainers.

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HOW TO MODIFY THE BACK SQUAT FOR LOWER BACK PAIN

DANIEL BONILLA, PHD, ATC AND GUILLERMO ESCALANTE, DSC, MBA, ATC, CSCS,*D, FISSN

Personal trainers, strength and conditioning coaches, and sports medicine professionals use the conventional back squat (CBS) because it has been shown to improve athletic performance, help reduce the prevalence of injuries, and rehabilitate injuries (6,8,10,13,44). Although it is an effective exercise that offers many benefits, personal trainers must know how to properly evaluate, teach, progress, and modify the CBS for clients who suffer from lower back pain (LBP) (21). Modifying the CBS to improve spinal stability and strength in the lower limbs may potentially decrease the prevalence of LBP among clientele.

Various strategies can be used to modify the CBS ranging from altering the exercise altogether to making modifications to the exercise itself. For example, the hack squat exercise can be used when the goal is to strengthen both knee and spinal stabilizers and can be substituted for the CBS if clients report LBP prior to or during the CBS (10). Similarly, the front squat exercise can be substituted to minimize the load on the spinal stabilizers and target the quadriceps muscle group (10). By changing the exercise and positioning of the bar, the personal trainer can use the front squat to focus on muscles of the lower limb and decrease stress in the lower back. Modifying the CBS and incorporating exercises that decrease the load on the lumbar spine may minimize LBP (1). Prior to making modifications, personal trainers must be able to recognize LBP as a musculoskeletal injury that affects many people (37,43). Personal trainers must also learn the nuances of the CBS technique and use modifications (e.g., squat variations) for clients who report LBP (32). Although this article will not cover the breadth and depth of knowledge regarding CBS and LBP among active and non-active individuals, it will provide personal trainers with eight modifications that clients can benefit from if they suffer from both acute and chronic LBP.

LOW BACK PAIN

A common reason for visiting a medical doctor is to manage pain. In 2019, a national health survey found that 50.2 million adults in the United States (20.5%) reported chronic pain on either most days or every day (43). For people who suffer from chronic LBP, pain can range from 4 – 12 weeks or longer (4,22). When compared to other areas of the body like the hip, knee, and foot, chronic LBP was reported as one of the most common among US adults (44). Roughly 15 – 20% of adults report back pain in a single year and it is estimated that 50 – 80% of adults report LBP at any given point in their life (37,39). Women report slightly higher rates of LBP when compared to men. In 2018, 28% of men and 32% of women living in the US reported LBP in the past three months (37). LBP has slowly become the most prevalent cause of disability among the US working-class population (37).

LBP is one of the most prevalent causes of disability when compared to other types of medical conditions like strains, sprains, arthritis, rheumatism, carpal tunnel, and heart disease (4,5). According to a national health survey, out of 31,997 adults over the age of 18, 39% reported back pain in the past three months (29). LBP is generally caused by strained skeletal muscles or sprained ligaments and is associated with poor posture, arthritis, ruptured intervertebral disks, inactivity, and improper lifting. LBP symptoms can also arise from spinal stenosis, spinal nerve roots, fascial structures, and abdominal organs (1,12,26). Although pain is subjective and unique to each client, personal trainers can classify LBP based on the duration of symptoms. For example, acute LBP is defined as lasting less than four weeks, subacute LBP lasts between 4 – 12 weeks, and chronic LBP can last more than three months (5,23). If left untreated, LBP can develop into chronic nonspecific LBP which has been associated with pain, disability, and reduced quality of life (1,23). Furthermore, LBP that lasts more than three months can impact a client's functional and occupational activities (1). If left untreated, chronic LBP can even cause psychological issues such as stress, depression, and anxiety (1). To help clients minimize and even prevent acute and chronic LBP, personal trainers must be up to date on the benefits of using the CBS as a strength exercise and be able to incorporate modifications when pain in the lower back arises.

THE CONVENTIONAL BACK SQUAT

Squatting is a simple bodyweight movement that uses a variety of muscle groups (17). Predicting when a client may suffer from LBP during the CBS can be spotted by a personal trainer. For example, when a client performs the CBS and develops too much forward lean throughout the exercise, poor posture, and stress from the Olympic bar on the back may alter proper spinal alignment, which may result in overstretched tissues and subsequent pain (29). Thus, it is important for personal trainers to identify movement deficits, weakness, and instability during the CBS and provide appropriate feedback to clients (e.g., cues) to reduce the potentially harmful physical effects of LBP (e.g., clients experiencing radiating pain in their extremities, pain in their spinal column and sacroiliac joints, pain related to spinal stenosis, and discogenic pain) (1).

Deficits that can impair CBS performance include: a) inefficient motor unit coordination or recruitment, b) muscular tightness or weakness, c) muscular imbalances, and d) joint instability or immobility (33). Using the CBS repeatedly without proper form or prescribing it to clients who are not accustomed to the movement can intensify compressive and shear forces in the spine, hips, and knees, thus increasing the risk of clients reporting LBP or sustaining a spinal injury (18,40). Therefore, modifying the CBS and utilizing a multitude of exercises that still strengthen and reduce LBP is one approach for personal trainers to help their clients.

Additional methods to assist clients are to: 1) build trust by getting to know them individually, 2) ensure they properly warm up both

physically and mentally prior to exercise, 3) teach them how to breathe properly while lifting heavy loads and throughout all types of movement variations, 4) always require proper technique, and 5) progress clients slowly and safely according to their needs, abilities, and goals.

POTENTIAL APPLICATIONS

This article does not provide all the answers for helping clients avoid or decrease LBP, but it does provide personal trainers with methods to modify exercises like the CBS to help clients achieve their goals in a healthy and safe manner. The eight modifications addressed in this article are arranged from low- to high-intensity exercises and include: 1) breathing and bracing for core stability, 2) the seated leg press, 3) Smith machine and hack squat, 4) decreasing depth during the CBS and front squat, 5) double- or single-leg lunges, 6) elevating the heels during the CBS, 7) high- versus low-bar CBS, and 8) low-load blood flow restriction (BFR) training. Refer to Table 1 for a summary of each modification.

Personal trainers should think critically about how they can help clients achieve their goals when they experience LBP and take into consideration their level of fitness and their age. Aging is a natural process, but it can also lead to a reduction in skeletal muscle mass and strength, reduced quality of life, and increased risk of mortality in sedentary individuals (37). Personal trainers must still use logic and reasoning when working with clients of a specific age group and who have a history of or who are currently suffering from LBP to ensure client safety and avoid negligence. Also, if a personal trainer believes their client is experiencing LBP, the personal trainer should refer them to a medical specialist prior to beginning a strength training program. The personal trainer should communicate with their clients and ensure that they are cleared by their medical doctor to perform the prescribed movements before returning to the strength program. It is also important to collaborate with a medical team to select appropriate exercises for clients who are experiencing LBP.

Modifying the CBS to improve strength and decrease LBP can be thought to occur on a spectrum, starting with easy tasks (e.g., like breathing and bracing the torso while moving) and progressing towards more difficult tasks that involve the whole body (e.g., front squat and high- or low-bar positions). This modification guide is meant to be used in conjunction with each personal trainer's personal and professional experiences, and evidence-based practice.

CONCLUSION

Remember that LBP is a complex musculoskeletal disease that can affect anyone and at any time. Personal trainers should seek to incorporate modifications to the CBS and learn to appropriately select the best strength exercises for clients who suffer from acute or chronic LBP. Although personal trainers can educate and guide clients who have LBP on how to properly modify the CBS, clients are responsible for being aware and listening to their bodies when they experience pain or discomfort and collaborate with their personal trainer to safely achieve their goals. To effectively incorporate these modifications, personal trainers should make sure to collaborate with a multidisciplinary team of professionals (e.g., medical professionals, physical therapists, certified athletic trainers, and other personal trainers) to ensure clients are developing strength and reducing LBP in a conservative yet challenging manner.

TABLE 1. MODIFICATIONS FOR THE CBS WHEN CLIENTS HAVE LBP FROM LOW TO HIGH LEVELS OF DIFFICULTY

AUTHOR/S AND DATE	WHY USE THIS MODIFICATION?	WHEN TO USE THIS MODIFICATION	*DIFFICULTY
McGill (2001; 2007) Lourin et al. (2022) Ribeiro et al. (2020)	**Breathing and Bracing for Core Stability** • When clients have a weak core or have LBP, clients can breathe in deeply and expand their ribs laterally, which promotes core/trunk tension and stability when lifting low to heavy loads.	• At the beginning of the CBS, instruct clients to breathe in deeply and expand their ribs not the abdomen. Then have them hold and brace, slowly exhaling as the movement is completed. Implement the McGill Big Three (the curl-up, side plank, and bird-dog) using low loads and incorporate breathing and bracing techniques during the CBS.	Low
Naamat et al. (2014) Ribeiro et al. (2020)	**Seated Leg Press** • The seated leg press mimics the CBS and incorporates leg extension and flexion while the upper body is fixed, producing a greater response in the vastus muscles and may improve knee extension strength in older clients.	• Help the client understand how to use the seated leg press with lighter weight then slowly increase the load as they get accustomed to the movement. • Instruct the client to move the platform away in a controlled manner throughout the full range of motion and to return the platform slowly.	Low

HOW TO MODIFY THE BACK SQUAT FOR LOWER BACK PAIN

AUTHOR/S AND DATE	WHY USE THIS MODIFICATION?	WHEN TO USE THIS MODIFICATION	*DIFFICULTY
Clark et al. (2019) Ribeiro et al. (2020)	**Smith Machine and Hack Squat** • When clients present with a reduction of strength and skeletal muscle mass in the lower versus upper extremities, using the Smith machine or hack squat are more supportive exercises to use when compared to the CBS. **Smith Machine**: The weighted bar is fixed and does not move within the three dimensions of space. It is a safe alternative for clients who are older and who suffer from LBP. **Hack Squat**: The hack squat can offer clients more support when compared to the Smith machine because the movement is performed in a fixed machine angled at 45 degrees. The hack squat can elicit greater strength gains in untrained clients.	**Smith Machine** • Help your client be comfortable with the fixed bar position on their back and have them perform the CBS with no weight. Then slowly progress to using low, moderate, and heavy weight according to your client's needs. **Hack Squat** • The client places their feet on the hack squat platform and applies force against the shoulder pads to mimic a CBS. Like the Smith machine, personal trainers should use light weight at first, and slowly progress their clients as they gain strength and confidence.	Moderate
Cotter et al. (2013) Diggin et al. (2011)	**Decreasing Depth during the CBS and Front Squat** • Decreasing depth during the CBS and front squat can minimize potentially dangerous high forces on the knee during the CBS and front squat and reduce the likelihood of injury to the spine. • When compared to the CBS, the front squat with minimal loads can elicit more knee flexion because the movement is performed in an upright posture and with less shear forces.	• Instruct clients to perform the CBS or front squat using verbal cues such as, "do not go all the way down during the squat, stay above parallel to the floor. Slowly progress to parallel and below parallel as you gain confidence in the movement." Begin by not applying a load to the bar so clients get accustomed to each depth. Then carefully add heavier loads when performing above parallel squats, and reduce the load when clients are performing parallel or below parallel squats.	Moderate
Glassbrook et al. (2017) Glassbrook et al. (2019)	**High- and Low-Bar CBS** • High- and low-bar CBS can help clients with previous LBP increase strength gains in their lower extremities and develop greater core and spinal stability. The low-bar CBS is reported to produce increased skeletal muscle activation of the erector spinae group, adductors muscles, and glutes.	• Personal trainers should plan and use either the high or low-bar CBS when their clients require strength development of the lower limbs or postural muscles.	High
Bezarra et al. (2021) Krause et al. (2018) Mausehund et al. (2019)	**Double or Single-Leg Lunges** • These exercises require multiple joints and greater activation of the hips, glutes, and knee extensors.	• During lunging exercises, clients can either use their own body weight for resistance or use dumbbells, weighted barbells, kettlebells, and elastic bands for added resistance. When performing a single-leg squat, have one leg supported on an elevated surface while the other leg is flat on a stable surface.	High

AUTHOR/S AND DATE	WHY USE THIS MODIFICATION?	WHEN TO USE THIS MODIFICATION	*DIFFICULTY
Pangan et al. (2021) Sayers et al. (2020)	**Elevated Heels During the CBS** • Weightlifting shoes with built-in heel wedges have been shown to reduce excessive trunk lean and produce greater plantarflexion in the ankles when compared to running shoes or exercising barefooted. • Elevated heels during the CBS can reduce shear forces on the knees by restricting excessive anterior knee movements. Furthermore, elevating the heels can be more beneficial for novice lifters.	• Incorporate shoes with built-in heel wedges or use external squat wedges during the CBS exercise. Allow time for clients to get accustomed to their heels being elevated during the CBS exercise and help them understand why their heels are elevated as opposed to flat on the ground.	High
Ladlow et al. (2018) Lorenz et al. (2021)	**Low-Load BFR Training** • This can help clients develop skeletal muscle mass and strength in the lower extremities.	• Learn how to use the quick inflating blood flow restriction (BFR) tourniquet and be comfortable instructing clients on how BFR works and why you are including it in their training regime. Apply the BFR device to the proximal portion of the lower limb. Then properly inflate the tourniquet and ensure that the client is comfortable during the CBS movement.	High

**Level of difficulty was established solely by the authors' personal experiences using each CBS modification and without scientific evidence to help personal trainers and clients understand how easy or difficult these modifications can be to use in real world settings.*

REFERENCES

1. Allegri, M, Montella, S, Salici, F, Valente, A, Marchesini, M, Compagnone, C, et al. Mechanisms of low back pain: A guide for diagnosis and therapy. *F1000Research* 5: 2016.

2. American College of Sports Medicine. American College of Sports Medicine position stand. Progression models in resistance training for healthy adults. *Medicine and Science in Sports and Exercise* 41: 687-708, 2009.

3. Bezerra, EDS, Diefenthaeler, F, Nunes, JP, Sakugawa, RL, Heberle, I, Moura, BM, et al. Influence of trunk position during three lunge exercises on muscular activation in trained women. *International Journal of Exercise Science* 14: 202-210, 2021.

4. Centers for Disease Control and Prevention. Prevalence and most common causes of disability among adults—United States, 2005. *Morbidity and Mortality Weekly Report* 58: 421-426, 2009.

5. Centers for Disease Control and Prevention. Acute low back pain. January 2021. Retrieved 2022 from https://www.cdc.gov/acute-pain/low-back-pain/index.html.

6. Clark, DR, Lambert, M and Hunter, A. Trunk muscle activation in the back and hack squat at the same relative loads. *Journal of Strength and Conditioning Research* 33(Suppl 1): S60-S69, 2019.

7. Contreras, B, Vigotsky, AD, Schoenfeld, BJ, Beardsley, and Cronin, J. A comparison of gluteus maximus, biceps femoris, and vastus lateralis electromyography amplitude in the parallel, full, and front squat variations in resistance-trained females. *Journal of Applied Biomechanics* 32: 16-22, 2016.

8. Cotter, JA, Chaudhari, AM, Jamison, ST, and Devor, ST. Knee joint kinetics in relation to commonly prescribed squat loads and depths. *The Journal of Strength and Conditioning Research* 27: 1765-1774, 2013.

9. DeForest, BA, Cantrell, GS, and Schilling, BK. Activity in single- vs. double-leg squats. *International Journal of Exercise Science* 7: 302-310, 2014.

10. Deniz, E, and Ulas, YH. Evaluation of muscle activities during different squat variations using electromyography signals. In: Aliev, R, Kacprzyk, J, Pedrycz, W, Jamshidi, M, Babanli, M, and Sadikoglu, F (eds) 10th International Conference on Theory and Application of Soft Computing, Computing with Words and Perceptions - ICSCCW-2019. *Advances in Intelligent Systems and Computing* 1095: 2020.

11. Deyo, RA, and Weinstein, JN. Low back pain. *The New England Journal of Medicine* 344: 363-370, 2001.

12. Dieleman, JL, Cao, J, Chapin, A, Chen, C, Li, Z, Liu, A, et al. US health care spending by payer and health condition, 1996–2016. *The Journal of the American Medical Association* 2020.

13. Diggin, C, O'Regan, NW, Daly, WS, McLoughlin, L, McNamara, L and Reilly, A. A biomechanical analysis of front versus back squat: Injury implications. *Biomechanics in Sports* 29: 643-646, 2011.

14. Escamilla, RF, Fleisig, GS, Zheng, N, Lander, JE, Barrentine, SW, Andrews, JR, et al. Effects of technique variations on knee biomechanics during the squat and leg press. *Medicine and Science in Sports and Exercise* 33: 1552-1566, 2001.

15. Franklin, B, Whaley, M, Howley, E, and Balady, G. *ACSM's Guidelines for Exercise Testing and Prescription: Testing and Prescription*. Lippincott Williams and Wilkins: 2000.

16. Garber, CE, Blissmer, B, Deschenes, MR, Franklin, BA, Lamonte, MJ, Lee, IM, et al. American College of Sports Medicine position stand. Quantity and quality of exercise for developing and maintaining cardiorespiratory, musculoskeletal, and neuromotor fitness in apparently healthy adults: Guidance for prescribing exercise. *Medicine and Science in Sports and Exercise* 43: 1334-1359, 2011.

17. Glassbrook, DJ, Brown, SR, Helms, ER, Duncan, S, and Storey, AG. The high-bar and low-bar back-squats: A biomechanical analysis. *The Journal of Strength and Conditioning Research* 33: S1-8, 2019.

18. Glassbrook, D, Helms, E, Brown, S, and Storey, A. Biomechanical differences between the high-bar and low-bar back squat. *Journal of Strength and Conditioning Research* 31: 2618-2634, 2017.

19. Gullett, JC, Tillman, MD, Gutierrez, GM, and Chow, JW. A biomechanical comparison of back and front squats in healthy trained individuals. *Journal of Strength and Conditioning Research* 23: 284-292, 2009.

20. Hoyt, BW, Pavey, GJ, Pasquina, PF, and Potter, BK. Rehabilitation of lower extremity trauma: A review of principles and military perspective on future directions. *Current Trauma Reports* 1: 50-60, 2015.

21. Kasovic, J, Martin, B, and Fahs, CA. Kinematic differences between the front and back squat and conventional and sumo deadlift. *Journal of Strength and Conditioning Research* 33: 3213-3219, 2019.

22. Katz, JN. Lumbar disc disorders and low-back pain: Socioeconomic factors and consequences. *The Journal of Bone and Joint Surgery, American Volume* 88: 21-24, 2006.

23. Kell, RT, Risi, AD, and Barden, JM. The response of persons with chronic nonspecific low back pain to three different volumes of periodized musculoskeletal rehabilitation. *Journal of Strength and Conditioning Research* 25: 1025-1064, 2011.

24. Knezevic, NN, Candido, KD, Vlaeyen, JWS, Van Zundert, J, and Cohen, SP. Low back pain. *Lancet* 398: 78-92, 2021.

25. Krause, DA, Elliott, JJ, Fraboni, DF, McWilliams, TJ, Rebhan, RL, and Hollman, JH. Electromyography of the hip and thigh muscles during two variations of the lunge exercise: A cross-sectional study. *International Journal of Sports Physical Therapy* 13: 137-142, 2018.

26. Ladlow, P, Coppack, RJ, Dharm-Datta, S, Conway, D, Sellon, E, Patterson, SD, and Bennett, AN. Low-load resistance training with blood flow restriction improves clinical outcomes in musculoskeletal rehabilitation: A single-blind randomized controlled trial. *Frontiers in Physiology* 9: 1269, 2018.

27. Laurin, E, Minerbi, A, Besemann, LM, Courchesne, I, and Gupta, G. The McGill approach to core stabilization in the treatment of chronic low back pain: A review. *Canadian Military Pain and Rehabilitation Journal* 4: 2022.

28. Lorenz, DS, Bailey, L, Wilk, KE, Head, P, Grindstaff, TL, and Morrison, S. Blood flow restriction training. *Journal of Athletic Training* 56: 937-944, 2021.

29. Lucas, JW, Connor, EM, and Bose, J. Back, lower limb, and upper limb pain among U.S. adults, 2019. U.S. Department of Health and Human Services, Centers for Disease Control and Prevention. *National Center for Health Statistics Data Brief* 415: 1-7, 2021.

30. Mausehund, L, Skard, AE, and Krosshaug, T. Muscle activation in unilateral barbell exercises: Implications for strength training and rehabilitation. *The Journal of Strength and Conditioning Research* 33: S85-94, 2019.

31. McGill, SM. Low back stability: From formal description to issues for performance and rehabilitation. *Exercise and Sport Sciences Reviews* 29: 26-31, 2001.

32. McGill, SM. *Low Back Disorders: Evidence-Based Prevention and Rehabilitation.* Champaign, IL: Human Kinetics; 2007.

33. Myer, GD, Kushner, AM, Brent, JL, Schoenfeld, BJ, Hugentobler, J, Lloyd, RS, et al. The back squat: A proposed assessment of functional deficits and functional factors that limit performance. *Strength and Conditioning Journal* 36: 4-27, 2014.

34. Naamat, KK, Sadeghi, H, Sahebozamani, M, and Nazari, S. Effects of seated leg press exercise on knee extension strength in elderly. *Journal of Research in Rehabilitation Sciences* 10: 539-548, 2014.

35. Neitzel, JA, and Davies, GJ. The benefits and controversy of the parallel squat in strength training and rehabilitation. *The Journal of Strength and Conditioning Research* 22: 30-37, 2000.

36. NSCA position paper. The squat exercise in athletic conditioning: A position statement and review of the literature. *Strength and Conditioning Journal* 13: 51-58, 1991.

37. Pangan, AM, and Leineweber, M. Footwear and elevated heel influence on barbell back squat: A review. *Journal of Biomechanical Engineering* 143: 2021.

38. QuickStats: Percentage of adults aged 18 or more years who had lower back pain in the past 3 months, by sex and age group. National Health Interview Survey, United States, 2018. Retrieved 2022 from https://nchstats.com/2020/01/03/quickstats-percentage-of-adults-aged-18-years-or-older-who-had-lower-back-pain-in-the-past-3-months-by-sex-and-age-group/.

39. Ribeiro, AS, Nunes, JP, and Schoenfeld, BJ. Selection of resistance exercises for older individuals: The forgotten variable. *Sports Medicine* 2020.

40. Rubin, DI. Epidemiology and risk factors for spine pain. *Neurologic Clinics* 25: 353-371, 2007.

41. Sayers, MGL, Bachem, C, Schutz, P, Taylor, WR, List, R, Lorenzetti, S and Hosseini Nasab, SA. The effect of elevating the heels on spinal kinematics and kinetics during the back squat in trained and novice weight trainers. *Journal of Sports Sciences* 1-9, 2020.

42. Slysz, J, Stultz, J, and Burr, JF. The efficacy of blood flow restricted exercise: A systematic review and meta-analysis. *Journal of Science and Medicine in Sport* 19: 669-675, 2016.

43. Wilson, S, Goodman, W, Casillas, C, Zavala, L, and Becker, J. Improving posterior chain engagement and forward trunk lean during the front squat. *Medicine and Science in Sports and Exercise* 50: 430-431, 2018.

44. Yong, RJ, Mullins, PM, and Bhattacharyya, N. Prevalence of chronic pain among adults in the United States. *Pain* 163: e328-e332, 2022.

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RETAIN YOUR CLIENTS BY PROVIDING A GREAT EXPERIENCE

JIM CLEVELAND, CSCS

So, your referral network continues to be successful, your lead generator consistently brings in qualified people, and you have great sales copy. Your client base is where you want it to be. The question is: "how do you retain your clients?" You do it by providing coaching, accountability, attentiveness, knowledge, and service.

How are you determining how your clients learn? Some people learn visually (e.g., seen or observed things), some auditory (e.g., the transfer of information through listening to the spoken word), and some kinetically (e.g., touching, feeling, holding, doing, practical hands-on physical experiences) (2).

Visually demonstrating the exercise movement pattern prior to your client executing it and also verbally explaining potentially helps increase the success of proper execution by your client, then you can have them actually perform the movement pattern. You will need to cue your client right at the start of the execution of the movement pattern. You will cue them during the kinetic part of the movement pattern because you want to make sure that your client is activating the proper muscle groups, and check to make sure they are not deviating from the proper movement pattern. You will cue them after the execution of their last repetition of the set, to tell them that they have successfully completed that exercise.

What is your approach to making your clients "experience" the service that you provide? In the initial part of onboarding your clients, you should be noting their goals and concerns (e.g., pre-existing injuries). Performing an assessment which addresses mobility, strength, and endurance, provides your clients with an important benchmark in moving forward. It is important to keep your clients challenged in order to promote growth, and that means not just increasing their level of resistance on exercises, but also in the area of short-term and long-term goals.

Make sure you are giving clients your complete attention during sessions. Rather than giving a fraction of your attention, active listening is making a conscious effort to hear, understand, and retain information that is relayed to you. It involves more than listening to the words they say. Building trust is paramount with your clients. They will confide in you, and purposely or inadvertently share personal information with you. Demonstrate that you have compassion, and will not judge them for their choices, be supportive and offer insight at the appropriate time.

What is your body language saying? How do you greet your client at the start of a training session? Are you engaged? When you greet your client, smile, keep an open posture, and use a tone in your voice that makes them feel welcome. When the session is going well, both you and your client will mirror each other's posture and movement. That will help in building a relationship with your client. Your eye contact portrays interest, but you should not glare or stare down your client.

You should not cross your arms across your chest while training your client. This can potentially project a level of defensiveness, being standoffish, or arrogant. You should never sit down or cross your arms or legs when training your client while they are standing. Potentially, this can project a sign of resistance, lack of interested, or being closed off. You need to be close enough to provide assistance to your clients if they need it. Doing these things will enhance your client's experience. You do not want to be "lying down on the job."

Being knowledgeable and certified is important, because having the right information to create the right training program for your client is invaluable and key to making progress. It is also important to be certified through a nationally established organization as it legitimizes who you are as a professional and helps you with your level of convinceability. To remain certified, you will need to take continuing education courses. There are many to choose from and the best choices will be the courses that benefit the type of clients that you train the most.

You should have some professional connections such as a Registered Dietitian in case your clients need additional help that is out of your scope of practice. Also, you should have a physical therapist that you can refer your clients to if needed. There might be issues that your clients may have that warrant special therapy, which is out of your scope of practice. Also, you should have a mental health counselor as part of your referral system. It is out of your scope of practice to try and resolve issues dealing with your client's mental well-being. You might encounter a situation where they will need help that is beyond your scope of practice. Do not be apprehensive about having your clients work with someone else. Think about it as enhancing their experience in a positive way. It will show that you have your client's best interest in mind.

What you give, you get back with client loyalty, and that is by giving quality service. It starts with a positive attitude (1). Treat them the way that you want to be treated. Prepare for each client before the scheduled training session and let your creativity lead the way. Encourage your clients when they need support. Have something nice or humorous to say. Do not eat in front of your client. Do not use your Smartphone (texting and talking) while training your client. Their experience is truly about them. Get to know your client, what are their interests and hobbies? Do they come from a large or small family? What important events are on the horizon for them (birthday, anniversary, or vacation)? If they are participating in a future event, try to attend if possible to show your support. Document success by recruiting your

clients to participate and using testimonies, they can be written or in a video format (1). Your loyal clients would be more than happy to contribute to your cause as it allows them to talk about themselves and their success.

You should set yourself apart from other personal trainers. You can offer stretching, mobility, and nutrition tips, something they could use every day. This could be classified as "service beyond the workout" (1). Treat every client in such a memorable way that when the session is complete, the client tells everyone or at least one other person how great it was. In the end, the only perspective that matters is the client's (1).

REFERENCES

1. Gitomer, J. *Customer Satisfaction is Worthless, Customer Loyalty is Priceless*. Austin, TX: Bard Press; 209-270, 1998.

2. How to accommodate different learning styles, 2022. Retrieved May 2022 from https://www.umassd.edu/dss/resources/faculty-staff/how-to-teach-and-accommodate/how-to-accommodate-different-learning-styles/.

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THE FMS™ ACTIVE STRAIGHT LEG RAISE – SCREENING AND CORRECTIVE EXERCISE CONSIDERATIONS FOR PERSONAL TRAINERS WITH MINIMAL FMS™ EXPERIENCE

GRAYSON ELMORE, PHD, ATC, CSCS

The Functional Movement Screen (FMS™) is a polarizing, but common movement screen used in various performance and rehabilitation settings (7). Globally, the FMS is a quick and reliable screen that can provide insight into a client's strengths and areas of improvement with fundamental movement patterns that reflect common strength training exercises (e.g., squat, Romanian deadlift, and shoulder press) (1). Specifically, FMS results can help the personal trainer determine the direction of the client's training program or if a client has pain with basic movement patterns, which would necessitate a referral to a healthcare provider (1). Elements of the FMS such as reliability, validity, and injury predictive capabilities are well established in the research (7). A central theme of FMS research has been the ability of the movement screen to predict injury via the overall composite score calculation, with the basic implementation, scoring, and calculation of the FMS composite score well-documented in the research (3). Currently, most publications identify a limited ability of the FMS composite score to predict injury, with most publications recommending a greater investigation (and focus) on the individual movement patterns within the FMS and movement asymmetries (7). What is currently lacking in the present FMS research is a more intimate exploration of each individual pattern and the unique screening and corrective exercise integration decisions that are relevant to the personal training industry. Therefore, this article is the first in a planned article series to review essential considerations of each FMS pattern; this article will examine the FMS active straight leg raise (ASLR) in greater detail to help personal trainers with minimal FMS experience better understand the pattern, consistently identify movement compensations, and effectively integrate ASLR corrective exercises into their current training programs.

PATTERN OVERVIEW

The ASLR (also known as the reciprocal lower body pattern) is a multi-faceted pattern that primarily assesses a client's pelvic disassociation (i.e., the ability to create flexion on one limb and extension on the other) capabilities (2). Pelvic disassociation is a critical developmental sequence reflected in various exercises and daily movements (e.g., rolling, crawling, walking, running, skipping). Also, the pattern allows for an assessment of the client's ability to effectively transfer load between the spine and lower extremities, which is important for strength and conditioning movements such as the hip hinge and deadlift (5).

To complete the ASLR, the client actively moves one limb through hip flexion (with the knee straight), which requires adequate hamstring and calf flexibility, while the opposite limb must reciprocally extend, which requires adequate hip flexor flexibility (5). The ASLR allows for assessment of both the client's right and left leg pelvic disassociation and load transfer abilities. The client's core activation strategies (feedforward versus feedback), pelvic orientation (anterior versus posterior tilt), open chain knee extension, and open chain ankle dorsiflexion capabilities all contribute to the client's ability to complete the ASLR pattern (5). Personal trainers should remember that the ASLR is a multi-faceted pattern with the spine in a fixed and supported position; thus, deficient performance on the ASLR is not solely because of hamstring or calf flexibility issues on the moving extremity and may highlight compensatory strategies used during quadruped, kneeling, and standing exercises (4).

SCREENING CONSIDERATIONS AND MOVEMENT COMPENSATIONS

Previous publications have documented the proper setup, cues, and FMS scoring criteria for the ASLR (2). For a client to receive a functional score (i.e., an ordinal score of "3"), they must demonstrate the ability to get the malleolus of their moving leg (maintaining a straight knee) past a vertical dowel rod (Figure 1) positioned halfway between their hip and knee (mid-thigh) with the non-moving limb (i.e., the stationary leg) remaining in the neutral test setup position (2). The challenge of the ASLR for providers new to the movement screen is visually watching both limbs simultaneously while determining if the malleolus clears the mid-thigh before any compensations are present. Often, new providers focus exclusively on the moving leg and miss compensatory changes in the non-moving limb that would affect the client's score (i.e., ordinal scores of "2" or "1").

For example, Figure 2 represents a scenario where a client's non-moving limb externally rotates out of the neutral test position before the client's moving leg malleolus clears the vertical dowel rod. In this scenario, the test should stop at the point the neutral test position is lost, which would be indicative of a significant compensatory strategy that should be addressed with corrective interventions. Figure 3 represents a scenario where the client's non-moving knee flexes (the knee should remain in extension) before the moving limb malleolus clears the vertical dowel rod. Like the previous scenario, the test should stop at the point the neutral test position is lost, which will drastically change the client's score and our interpretation of the ASLR capabilities.

Finally, Figure 4 represents a scenario where the client is unable to keep their feet in the standardized test position (toes pointed toward the ceiling with soles of the shoes perpendicular to the floor) before the moving leg malleolus clears the vertical dowel rod. Once again, this compensatory strategy changes the assessment of ASLR performance and warrants the inclusion of corrective exercises into the client's existing training program. Globally, personal trainers using the ASLR as part of their client assessment should remember that the compensatory strategies referenced in Figures 2 – 4 are only considered compensations if they occur before the moving leg malleolus clears the vertical dowel rod.

FIGURE 1. FMS ORDINAL SCORE OF 3 ON THE ASLR

FIGURE 2. NON-MOVING LIMB EXTERNAL ROTATION

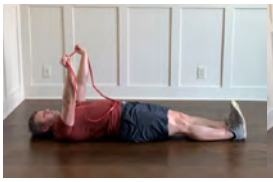
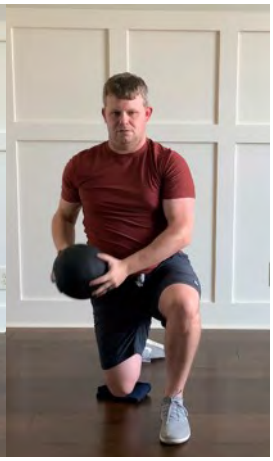
FIGURE 3. NON-MOVING LIMB KNEE FLEXION

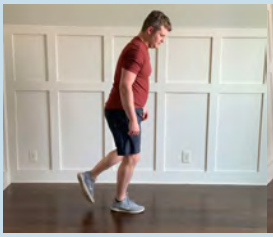
FIGURE 4. FEET OUT OF THE STANDARDIZED TEST POSITION

FIGURE 5. REVERSE PATTERN ASLR

FIGURE 6. REVERSE PATTERN ASLR

TABLE 1. SAMPLE ASLR CORRECTIVE EXERCISE PROGRESSION

EXERCISE	SETS X REPS	COACHING CUES	EQUIPMENT	START	FINISH
Feedback ASLR	1 – 3 x 10 – 12	**Position**: Lie flat on your back; keep the knuckles to the sky with constant tension in the band **Action**: Pull the band to the floor; raise the right leg (knee straight) as high as you can and then lower the right leg; repeat the action on the left side **Feel**: Back of the moving leg and stomach; no knee, hip, or back pain	Light to medium resistance band		
Mountain Climber	1 – 3 x 10 – 12	**Position**: Hands and toes into the ground (shoulder-width apart); neutral spine **Action**: Bring the right knee towards the right elbow keeping a neutral spine throughout; return to the start position and repeat on the left leg **Feel**: Front and back of the moving leg and stomach; no knee, back, or hip pain	Sliders or towel		
Half-Kneeling Chop	1 – 3 x 10 – 12	**Position**: Right knee on the ground; left leg in front with a 90/90/90 alignment (hip, knee, and ankle) **Action**: Bring the medicine ball from the left ear to the right hip (crossing the chest); return to the start position **Feel**: Stomach and arms; no knee, back, or shoulder pain **Comments**: 1. Toes can be either loaded into the ground (ankle dorsiflexion) or unloaded (ankle plantarflexion) 2. After completing a set of the exercise with the medicine ball moving from the left ear to the right hip, clients should change their leg position (left knee down and right leg up) and move the medicine ball from the right ear to the left hip	Light to medium resistance band or medicine ball		

EXERCISE	SETS X REPS	COACHING CUES	EQUIPMENT	START	FINISH
Single-Leg Deadlift	1 – 3 x 10 – 12	**Position**: Stand on the right leg with a soft bend in the knee and a neutral spine **Action**: Push hips back toward the wall while maintaining a neutral spine; return to the start position **Feel**: Hips and lower leg; no knee, hip, or back pain **Comment**: 1. After completing a set of the exercise, clients should change their leg position (stand on the left leg) and repeat the movement action	Bodyweight (the exercise can progress to light-medium load)		

CORRECTIVE EXERCISE INTEGRATION

Clients who do not achieve an ordinal score of "3" (i.e., functional) on the ASLR (both the right and left leg of the pattern) can complete corrective exercise strategies to improve their performance on the pattern. Corrective exercise integration can occur in various forms based on the preferences of the client and personal trainer.

For example, some personal trainers may decide that modifying the client's warm-up and cool-down to include specific ASLR corrective strategies is the best approach. Controversially, other personal trainers may decide to remove certain exercises (such as the hip hinge and Romanian deadlift pattern) from their client's program temporarily until the pattern improves; removal of an exercise such as a hip hinge is based on the transfer of load between the spine and lower extremity, which is important for strength and conditioning exercises such as the hip hinge or Romanian deadlift (5). Alternatively, other personal trainers may simply decide to add an ASLR corrective movement before their client completes a hip hinge or Romanian deadlift or provide their client with at-home exercises to complete.

Regardless of the approach the personal trainer decides to take, corrective strategies are an important part of the client's program to improve their pelvic disassociation, load transfer, and lower-extremity flexibility, all of which are reflected in their ASLR performance. Corrective exercises for the ASLR are not simply practicing the ASLR; instead, corrective exercises are exercises that reflect the different elements of the ASLR pattern (6). Progressive corrective exercises that mimic various postural positions (Table 1) and reverse-patterning exercises (Figure 5) improve the connection between the pattern and the exercises the client completes in their training program (6). The exercises presented in Figure 5 and Table 1 are based on movement pattern retraining, with each exercise designed to reinforce the mobility, stability, coordination, and timing needed to complete the ASLR successfully. For example, the feedback ASLR (Table 1) actively engages the client's core (via the band pull) before completing the ASLR, which helps reinforce the proper sequencing of core activation and proper pelvic orientation before the client completes the movement. The movement pattern retraining established with the feedback ASLR is then progressed over time (based on client form, movement quality, and exercise competence) with different postural challenges as reflected in the mountain climber, half-kneeling chop, and single-leg deadlift. The mountain climber, half-kneeling chop, and single-leg deadlift continue to reinforce the various elements of the ASLR pattern. Additionally, soft tissue techniques (e.g., foam rolling, static stretching, and dynamic stretching) for the muscles of the lower extremity (e.g., calves, hamstrings, hip flexors, tensor fasciae latae, and quadriceps) should be incorporated into the client's warm-up and cool-down to help address potential mobility and stability or postural limitations within the pattern.

CONCLUSION

The ASLR is a multi-faceted pattern that primarily assesses a client's pelvic disassociation, load transfer, and lower extremity flexibility characteristics; the pattern is reflected in common strength training exercises (e.g., Romanian deadlift) and postures (e.g., half-kneeling) (2). Clients who are unable to achieve a functional score on the ASLR (both the right and left leg) can benefit from corrective exercise strategies that improve the mobility, stability, coordination, and timing elements of the movement pattern. Corrective exercises for the ASLR should approximate the various functional requirements needed to complete the pattern, be completed with adequate form and quality, and progress over time. Personal trainers should communicate their approach to corrective exercise integration with their clients and that the FMS is comprised of seven unique fundamental movements; this article is only a review of the ASLR pattern and its associated corrective exercise considerations.

REFERENCES

1. Cook, G, Burton, L, Hoogenboom, BJ, and Voight, M. Functional movement screening: The use of fundamental movements as an assessment of function – Part 1. *The International Journal of Sports Physical Therapy* 9(3): 396-409, 2014.

2. Cook, G, Burton, L, Hoogenboom, BJ, and Voight, M. Functional movement screening: The use of fundamental movements as an assessment of function – Part 2. *The International Journal of Sports Physical Therapy* 9(4): 549-563, 2014.

3. Kraus, K, Schutz, E, Taylor, WR, and Doyscher, R. Efficacy of the Functional Movement Screen: A review. *Journal of Strength and Conditioning Research* 28(12): 3571-3584, 2014.

4. Medeiros, DM, Miranda, LL, Marques, VB, and Baroni, BM. Accuracy of the Functional Movement Screen (FMS™) active straight leg raise test to evaluate hamstring flexibility in soccer players. *The International Journal of Sports Physical Therapy* 14(6): 877-883, 2019.

5. Hu, H, Meijer, OG, Hodges, PW, Bruijn, SM, Strijers, RL, Nanayakkara, PWB, et al. Understanding the active straight leg raise (ASLR): An electromyographic study in healthy subjects. *Manual Therapy* 17(6): 531-537, 2012.

6. Takasaki, H, and Kawazoe, S. Active straight leg raising (ASLR) competence improves with reverse-ASLR exercises and not repeating ASLR exercises. *Journal of Exercise Rehabilitation* 17(1): 28-38, 2021.

7. Warren, M, Lininger, MR, Chimera, NJ, and Smith, CA. Utility of FMS to understand injury incidence in sports: Current perspectives. *Open Access Journal of Sports Medicine* 9: 171-182, 2018.

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THE 1X20 STRENGTH TRAINING PROGRAM FOR OLDER ADULTS

JOSH MCMILLIAN, MSA, CSCS,*D, RSCC*D

The 1x20 strength training program can potentially build strength with the older adult client by optimizing training volume and increasing training density. The author believes the potential benefits in the older adult clients by the 1x20 program include motor learning, improved capillary action, decreased soreness, and muscular adaptation in terms of both endurance and strength. The program gives each older adult client a baseline exposure to a lot of different exercises and movement patterns and helps build the general physical preparedness of the client.

OVERVIEW OF 1X20

The 1x20 program was developed by Dr. Michael Yessis, a sports performance coach and biomechanist who has worked with a number of elite individuals applying Soviet era training methods (5). The program is designed to strengthen all the muscles and joints of the body. Once strength is achieved, it then serves as a base for more advanced exercises with greater intensity, coordination, complexity and difficulty. The objective is to target all the joints and muscle groups and their actions in an effort to develop motor learning.

The 1x20 program keeps repetitions high but intensity low. A general starting point is to have the client begin at an intensity of 50% of their one-repetition maximum (1RM) for any given exercise. Most exercises are single-joint exercises and are aimed at targeting the major muscles, minor muscles, and joints of the body. Single-joint exercises allow targeting of specific muscles and joints for more concentrated work, especially for the muscles that are underdeveloped.

PROGRESSING THE 1X20

LEVEL 1

Level 1 is the beginning stage of resistance training in the 1x20 program. The goal of this level is for the client to learn and familiarize themselves with the exercises. It is important for the client to make gradual progress so that they can acclimate their body to the exercises without soreness or discomfort. A general starting point is to have the client begin at an intensity of 50% of their 1RM for the chosen exercises.

The number of exercises used during the first cycle of training that lasts four weeks should be between 6 – 12 exercises. This will vary depending on the client's level of fitness and exercise mastery. The personal trainer should pick exercises that are easy for the client to perform and that are easy on the client's joints and muscles. After the first cycle of training, the personal trainer should introduce 2 – 4 new exercises for their client. The goal is to eventually work up to 20 exercises targeting all the muscles in the body (5). If the client can perform 20 repetitions with a given exercise for 2 – 3 consecutive workouts, then the client may increase the resistance. The personal trainer should have their client stay in level 1 for 2 – 3 training cycles, each of which lasting four weeks until moving on to level 2.

LEVEL 2

Level 2 is an intermediate stage of resistance training in the 1x20 program. Personal trainers will continue to develop their client's foundation. Personal trainers will have their clients begin using a 1x14 approach for their exercises. Fewer repetitions will help the client gain strength while keeping a quality of endurance within their training. A general starting point is to have the client begin at an intensity of 65% of their 1RM for the chosen exercises. For this level, persoanl trainers should have their clients complete 2 – 3 training cycles before moving on to level 3.

LEVEL 3

Level 3 is an advanced stage of resistance training in the 1x20 program. The main distinguishing feature of this level is the addition of multiple sets for some of the exercises. The repetitions may be lowered to eight on some exercises with an increase in intensity up to 75% of the client's 1RM for the chosen exercises. With the addition of multiple sets, some exercises will need to be eliminated. The eliminated exercises should be those that have already given the client sufficient strength, and further increases are not needed at this time.

For exercises with multiple sets, 30 – 60 s of rest between sets is recommended for recovery. The client can do another exercise involving different muscles before completing a second set. Dr. Yessis discussed further levels, but these levels are likely unnecessary for the goals of the older adult population. For this level, personal trainers should have their clients complete multiple training cycles.

TRAINING PRINCIPLES

Dr. Yessis outlines several training principles in his book "The Revolutionary 1x20 RM Strength Training Program" (5). The principles that best serve the older adult population are gradualness, progressiveness, overload, awareness, and consistency. Gradualness and progressiveness are related in the fact that there will be steady progress in resistance, repetitions, and sets for the older adult client (5).

Overload means that the client does more than their body is accustomed to generally. For example, in order to develop strength, the cleint must add additional weight (resistance). Personal trainers can also overload the client by adding exercises or by adding sets to exercises to increase the volume.

The principle of awareness is used in two different ways. It usually refers to being cognizant of how you feel both mentally and

physically during and after an exercise. Awareness also means being cognizant of what is happening to the body during exercise. The client should learn what each exercise feels like and how the muscles are working. This allows the client to develop the muscle memory needed for effective execution (5).

Consistency is key to having older adult clients reach the goals they are striving for. An older adult client must exercise on a regular basis to reach their desired strength goals.

BENEFITS OF STRENGTH TRAINING FOR SENIORS USING THE 1X20 STRENGTH TRAINING PROGRAM

Level 1, cycle 1 of the 1x20 strength training program is effective because it starts with as little as six exercises, which would take a client as little as 20 min to complete and progresses the client to level 1, cycle 2 with as many as 12 exercises and 40 min of strength training exercise. This can help the client rebuild lost muscle tissue.

As the older adult client progresses from level 1 to level 3, they will have had several weeks of resistance training completed starting at a low volume and low intensity and moving up to a moderate volume at a higher intensity. This helps to increase bone and muscle mass by regaining strength, fitness, and physical abilities to help them be more efficient at performing daily tasks such as walking, getting off the floor, and picking up groceries.

The United States Department of Health and Human Services recommends that all adults do some type of strength training that hits all the major muscle groups at least two times per week (4). If health or ability prevents two full sessions, the recommendation is that older adults should do as much strength training as their

TABLE 1. LEVEL 1, PHASE 1 SAMPLE PROGRAM

EXERCISES	SINGLE-JOINT OR MULTI-JOINT	PRIMARY MUSCLES WORKED	NUMBER OF SETS	NUMBER OF REPETITIONS	INTENSITY
Leg Extension	Single-joint	Quadriceps	1	20	50% of 1RM
Leg Curl	Single-joint	Hamstrings	1	20	50% of 1RM
Hip Abduction	Single-joint	Hip abductors	1	20	50% of 1RM
Hip Adduction	Single-joint	Hip adductors	1	20	50% of 1RM
Biceps Curl	Single-joint	Biceps	1	20	50% of 1RM
Triceps Extension	Single-joint	Triceps	1	20	50% of 1RM
Abdominal Flexion	Single-joint	Rectus abdominis	1	20	50% of 1RM
Low Back Extension	Single-joint	Erector spine	1	20	50% of 1RM

TABLE 2. LEVEL 1, PHASE 2 SAMPLE PROGRAM

EXERCISES	SINGLE-JOINT OR MULTI-JOINT	PRIMARY MUSCLES WORKED	NUMBER OF SETS	NUMBER OF REPETITIONS	INTENSITY
Squat to Box	Multi-joint	Quadriceps, hamstrings, gluteal	1	20	50% of 1RM
Chest Press	Multi-joint	Pectoralis major, anterior deltoids, triceps	1	20	50% of 1RM
Seated Row	Multi-joint	Latissimus dorsi, biceps	1	20	50% of 1RM
Leg Extension	Single-joint	Quadriceps	1	20	50% of 1RM
Leg Curl	Single-joint	Hamstrings	1	20	50% of 1RM
Hip Abduction	Single-joint	Hip abductors	1	20	50% of 1RM
Hip Adduction	Single-joint	Hip adductors	1	20	50% of 1RM
Biceps Curl	Single-joint	Biceps	1	20	50% of 1RM
Triceps Extension	Single-joint	Triceps	1	20	50% of 1RM
Abdominal Flexion	Single-joint	Rectus abdominis	1	20	50% of 1RM
Rotary Torso	Multi-joint	Rectus abdominis, external obliques, internal obliques	1	20	50% of 1RM
Low Back Extension	Single-joint	Erector spine	1	20	50% of 1RM

TABLE 3. LEVEL 2 SAMPLE PROGRAM

EXERCISES	SINGLE-JOINT OR MULTI-JOINT	PRIMARY MUSCLES WORKED	NUMBER OF SETS	NUMBER OF REPETITIONS	INTENSITY
Squat to Box	Multi-joint	Quadriceps, hamstrings, gluteal	1	14	65% of 1RM
Chest Press	Multi-joint	Pectoralis major, anterior deltoids, triceps	1	14	65% of 1RM
Leg Press	Multi-joint	Quadriceps, hamstrings, gluteal	1	14	65% of 1RM
Seated Row	Multi-joint	Latissimus dorsi, biceps	1	14	65% of 1RM
Leg Extension	Single-joint	Quadriceps	1	14	65% of 1RM
Leg Curl	Single-joint	Hamstrings	1	14	65% of 1RM
Hip Abduction	Single-joint	Hip abductors	1	14	65% of 1RM
Hip Adduction	Single-joint	Hip adductors	1	14	65% of 1RM
Chest Fly	Single-joint	Pectoralis major	1	14	65% of 1RM
Reverse Fly	Single-joint	Upper trapezius, rhomboids	1	14	65% of 1RM
Biceps Curl	Single-joint	Biceps	1	14	65% of 1RM
Triceps Extension	Single-joint	Triceps	1	14	65% of 1RM
Abdominal Flexion	Single-joint	Rectus abdominis	1	14	65% of 1RM
Rotary Torso	Multi-joint	Rectus abdominis, external obliques, internal obliques	1	14	65% of 1RM
Low Back Extension	Single-joint	Erector spine	1	14	65% of 1RM

TABLE 4. LEVEL 3 SAMPLE PROGRAM

EXERCISES	SINGLE-JOINT OR MULTI-JOINT	PRIMARY MUSCLES WORKED	NUMBER OF SETS	NUMBER OF REPETITIONS	INTENSITY
Chest Press	Multi-joint	Pectoralis major, anterior deltoids, triceps	2	8	75% of 1RM
Leg Press	Multi-joint	Quadriceps, hamstrings, gluteal	2	8	75% of 1RM
Seated Row	Multi-joint	Latissimus dorsi, biceps	2	8	75% of 1RM
Leg Curl	Single-joint	Hamstrings	2	8	75% of 1RM
Hip Abduction	Single-joint	Hip abductors	1	14	65% of 1RM
Hip Adduction	Single-joint	Hip adductors	1	14	65% of 1RM
Reverse Fly	Single-joint	Upper trapezius, rhomboids	1	14	65% of 1RM
Biceps Curl	Single-joint	Biceps	1	14	65% of 1RM
Triceps Extension	Single-joint	Triceps	1	14	65% of 1RM
Abdominal Flexion	Single-joint	Rectus abdominis	1	14	65% of 1RM
Rotary Torso	Multi-joint	Rectus abdominis, external obliques, internal obliques	1	14	65% of 1RM
Low Back Extension	Single-joint	Erector spine	1	14	65% of 1RM

abilities allow (4). The 1x20 strength training program is able to meet older adults where they are. You can begin an older adult client on a couple of single-joint exercises at a light intensity (50% of their 1RM) and progress them to several exercises including multi-joint movements at a high intensity (75% of their 1RM).

THE IMPORTANCE OF STRENGTH TRAINING FOR SENIORS

By the year 2050, the United States will experience considerable growth in its older population (6). The baby boomers, who began turning 65 in 2011, are largely responsible for what has been described as the "graying of America" (3,5). This considerable demographic shift in American society has been accompanied by a coinciding change in attitudes towards physical activity across the lifespan. The idea that physical activity should be practiced regardless of age or gender has been coupled with the promotion of personal fitness in older adults (3).

For many older adults, growing older seems to involve an inevitable loss of strength, energy, and vigor. The frailty and decreased energy associated with aging (e.g., difficulty walking for distances, climbing stairs, or carrying groceries) are largely due to muscle loss. Muscle loss results mainly from inactivity (7).

Muscle strength gradually decreases from the 30th year until about the 50th year of life. In the sixth decade of life, an accelerated, non-linear decrease by 15% has been observed, and by the eighth decade, this may be up to 30% (2). This results in a substantial impairment in the sensorimotor information exchange, with a reduction in the quality of intermuscular and intramuscular coordination. Functional losses in strength and balance capacity and increasing gait uncertainties are the result. As muscle strength decresaes it can also lead to falls, injuries, and chronic and degenerative illnesses (2,4).

Older adults are increasingly needing strength training more as they grow older to stay mobile for their everyday activities. With the goal of training to reduce the loss of muscle mass and the resulting loss of motor function, the 1x20 strength training program can be used to start older adults on a basic single-joint, low-intensity, low-volume program (4). Then the personal trainer can progress them into a program where they are able to incorporate multi-joint exercises with higher levels of intensity and volume to help them gain muscle mass and improve motor function.

REFERENCES

1. Baechle, T, and Westcott, W. *Strength Training Past 50. 3rd Edition*. Champaign, IL: Human Kinetics; 2-5, 2015.

2. Faulkner, JA, Larkin, LM, Claflin, DR, and Brooks, SV. Age-related changes in the structure and function of skeletal muscles. *Clinical and Experimental Pharmacology and Physiology* 34: 1091–1096, 2007.

3. Gard, M, Dionigi, R, Horton, S, Baker, J, Weir, P, and Dionigi, C. The normalization of sport for older people? *Annals of Leisure Research* 20(3): 253-272, 2017.

4. Mayer, F, Scharhag-Rosenberger, F, Carlsohn, A, Cassel, M, Müller, S, and Scharhag, J. The intensity and effects of strength training in the elderly. *Deutsches Arzteblatt International* 108(21): 359-364, 2011.

5. Yessis, M. *The Revolutionary 1×20 Strength Training Program*. Sports Training Inc; 81-94, 2014.

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CONSIDERATIONS FOR INCREASING SPEED OF AN IN-SEASON SOCCER ATHLETE

MICHAEL HALLBURN, CSCS, NSCA-CPT

INTRODUCTION

This article is based on a real-world coaching experience of training an elite 16-year-old high school senior in-season soccer athlete who sought to improve speed in 12 weeks during the season. Before this training program was implemented, the athlete was training above their age group, and the parents controlled everyday life. For situations like this, it is necessary to find a balance that delivers on outcomes and minimizes overtraining or injury. Modern evidence-based society requires sound research to be paired with coaching to deliver consistent results, otherwise the athletes may not come back (1). Therefore, the following is how a training program was built based on experience and research for an in-season soccer athlete emphasizing speed, while trying to complement their sport, minimize injury risk, and account for monitoring and proper exercise progression.

THE NEEDS ANALYSIS AND TRAINING LOAD ASSESSMENT

When considering where to begin, a needs analysis and training load assessment were performed. These were conducted in two parts: a physical assessment and injury history questionnaire, and a question-based survey for a full week of training. This athlete was in advanced home-schooled classes, slept an average of 5 – 6 hr a night, trained or exercised approximately 18 hr per week, and traveled many hours per week for training and competition. With a heavy soccer competition schedule, training schedule, travel, and academic demands, it became apparent the training will need to take this heavy load into consideration.

One study found that in a Division I college soccer season the cumulative fatigue from a heavy competition schedule decreased

TABLE 1. INITIAL TRAINING LOAD ASSESSMENT

ATHLETE TRAINING VOLUME AND INTENSITY	TIME	INTENSITY	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY	SUNDAY
Leg Lift	20 – 30 min	High	4.5	4.5	4.5			-	-
UB lift	20 – 30 min	Medium	3	3	3	3	3	-	-
Private Soccer	1 hr	High	5	5	5	5	-	-	-
Private Lift Session(s)	1 hr	High	5	-	4	-	-	-	-
Private Speed Session(s)	60 – 90 min	Med	4	-	4	-	-	-	-
Team Soccer Practice	1.5 hr	Medium-high	-	4.5	-	4.5	-	-	-
Games	2 hr	High	-	-	-	-	-	5	-
Recover Workout	1 hr	Low	-	-	-	-	-	-	2
Total Daily Training Time	-	-	4	3.5	3.75	3	0.5	2	1
Sleep Average	-	-	5 – 6 hr	5 – 6 hr	5 – 6 hr	5 – 6 hr	5 – 6 hr	5 – 6 hr	5 – 6 hr

Total Training Hours per Week	17.75
Average Intensity per Workout	4.075
Median Intensity per Week	4
Average Intensity for Sport Training	3.985

Intensity scale is based on an arbitrary scale of 1 – 5 (1 = low, 2= low-medium, 3 = medium, 4 = medium-high, 5 = high)

Table 1 details the survey I asked the parents of my athlete. I asked for the number of workout/training sessions they had, the length of each session, and the relative difficulty of each session. I charted the results assigning a 1 – 5 value for each workout, "1" being the easiest and "5" the hardest, then averaged the reults to determine the overall training load of the athlete. Any in-between numbers were established by the athlete as correct.

body weight, bodyfat percentage, VO_2max, and vertical jump of all the athletes on the team (9). This would indicate a high amount of physical stress is undertaken by the athletes and maintaining a high training load may not be manageable. Moreover, there can be significant reductions in speed and vertical jump height, and leg extensor strength can be impacted both at the end and even one week after the season is over (10). With such a lasting impact from the competitive season after the season is over, it seems evident that recovery strategies and synergistic training loads should be heavily considered.

When it came to the physical assessment, we identified the injury history—which was extensive—and the strengths and weaknesses of the athlete. Such weaknesses discovered in this athlete were minimal recruitment of the posterior chain, low back pain, overuse of the quadriceps, and too much overall fatigue. Physical strengths and weaknesses will vary from player to player, but from experience, these weaknesses are fairly common in soccer athletes, especially during a season.

Not only should the physical stressors be taken into account, but also the non-physical factors should be considered too. For instance, non-physical stressors for college athletes, like classes and study-hall, reduce athletes' free time and may impact sleep quality, both of which create additional psychological and social stress (2). This seemed relevant because this athlete repeatedly stayed up late to do homework and study for tests every week, many nights only getting 5 – 6 hr of sleep.

That said, the school workload had an impact on this athlete's recovery. With lost sleep, cognitive function could have been impaired, affecting their tactical skills, fine motor skills, and hormone levels (8). More to this point, they often reported high levels of fatigue and occasionally came into the gym tearing up. In these moments, the athlete was led outside and given a chance to talk out their problems away from parents or others. The workout volume would usually be shortened and the rest lengthened on these days. A tool often used was a scale of 1 – 10 for checking daily energy level, "10" being the most energy with "1" being completely exhausted, and the athlete consistently reported an average of 4 – 5. A lack of sleep became consistent, even normalized, and that plus the psychological stress of highly involved parents and advanced schoolwork could have already established a catabolic and highly sympathetic state.

When considering the fitness-fatigue paradigm, this athlete appeared to be overtraining (3). The fitness-fatigue paradigm is the current prevailing theory of training and adaptation, which suggests an inverse relationship between fitness and fatigue training responses. Simply put, the more athletes exercise, then the more fatigue will build to outweigh the training. It implies strategies that maximize fitness and minimize fatigue are more ideal to optimize an athlete's preparedness (7). Having fatigue outweigh the training could happen if their training is monotonous and lacks variety of loads and exercise selection. In fact, athletes tend to see a plateau or even loss of performance with their training when that training becomes monotonous, both in intensity and volume (4).

Additionally, soccer is a heavily anaerobic sport with high metabolic demands. For example, a study in 2015 found that elite European soccer players have approximately 58 sprints in a game with an average sprint distance total of 237±137m (10). With these intense anaerobic requirements combined with the other stressors in mind, it is a strong possibility that this athlete was already experiencing a state of non-functional overreaching, a state of diminishing performance and increased injury risk while maintaining a high level of training (3). With this theory, needs analysis, and total training load assessment in mind, the focus became about training a "quality over quantity" approach, prioritizing quality sets, quality workouts, and adequate work to rest ratios with the new program set to be 3 – 4 one-hour training sessions per week for 12 weeks.

TRAINING PLANS

First, there were no more than two days a week of resistance training, with only one resistance training day when they had two games that week. In fact, research has found that just a single gym-based session per week is sufficient to cause speed increase adaptations, and should time allow, a second session will be more beneficial (9). The choice for low volume of gym sessions is based on research that shows reduced performance can last up to 72 hr after a single game, which leaves minimal time during the week to train hard (2). Moreover, optimizing rest and recovery requires 7 – 9 hr of sleep and good sleep hygiene as this can help manage cortisol levels, mitigate catabolic effects, and aid in improved or at least maintained performance (8). We could only encourage this rest and recovery, but sleep was slowly given more priority.

Regarding the timing of the high-intensity training, coordination and communication with the parent about the match and travel schedules became very important. Heavy sessions were spaced to respect the 72 hr for recovery after the games played and before games of the coming weekend. If time allowed, then strength workouts had up to 96 hr of recovery before games, power/speed workouts had 48 hr, and combined days were 48 – 72 hr before games (10). As for the one to two other lower-intensity days, they were focused on active recovery, such as training running form, running economy, and strengthening weak muscles (primarily the posterior chain, adductors, and obliques).

PROCESS

To potentially find out why this athlete was not utilizing, feeling, or "sensing" their posterior chain, some Postural Restoration Institute® (PRI) assessment procedures were used to examine the neuromuscular range of motion of the hips, shoulders, and ribs. Similar to the testing process used by Jackson et al., the assessment relied on the adduction drop test (Ober's test), hip extension tests, glenohumoral internal rotation (GH-IR) tests, and others to determine how much range of motion (ROM) the joints had and the pattern in which the athlete moved (5). The ranges of motion tested were all less than optimal for natural movement,

TABLE 2. LAST MONTH IN-SEASON SCHEDULE

MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SAT	SUN
Active Recovery: Core, hip mobility, running drills, PRI	**Strength:** TB Squat 3x4 at 80% Mid-Thigh Pull 3x4 at 85% Step-Up 2x8/s at 40%BW	**OFF**	**Power and Speed:** Hang High-Pull 2x5 at 60% CMJ Shrug 2x6 at 40% WTD Pogos 2-3x6-8 at 20%BW 2x10-yd Sprints	**Travel**	**Game**	**Game**
OFF	**Active Recovery:** Core, hip mobility, running drills, PRI	**Power, Strength, Speed:** TB Squat 2x4 at 80% Hang High-Pull 2x3 at 70% WTD Pogos 2x6 at 20%BW 2x10-yd Sprints 1x15-yd Sprint	**OFF**	**Light:** Running form, treadmill intervals, core, and PRI techniques	**OFF**	**Game**
Active Recovery: Core, hip mobility, running drills, PRI	**Light:** Running form, treadmill intervals, core, and PRI techniques	**Power, Strength, Speed:** TB Squat 2x4 at 80% Hang High-Pull 2x3 at 70% WTD Pogos 2x6 at 20%BW 2x10-yd Sprints 1x15-yd Resisted Sprint	**Travel**	**Game**	**Game**	**Game**
OFF	**OFF**	**Active Recovery:** Core, hip mobility, running drills, PRI	**Strength:** TB Squat 3x4 at 80% Mid-Thigh Pull 3x4 at 85% Step-Up 2x8/s at 40%BW	**Light:** Running form, treadmill intervals, core, and PRI techniques	**OFF**	**OFF**

This table shows an example of the last month of the athlete's season and their training schedule with me. Not depicted are all of the soccer sessions they had nor the amount of travel.

let alone for high performance. Hip extension was less than 30º on both sides. The Ober's test was negative on both sides. As for the GH-IR, the right side had significantly less than the left side, indicating nonapical wall chest expansion. Furthermore, the athlete was overtrained in the sympathetic nervous output.

This assessment suggested a suboptimal neuromuscular connection to the inner obliques/transverse abdominus (IO/TA), hamstrings, and adductor muscles, as well as a potential over-reliance on back extensors, quadriceps/hip flexors, calves, and traps. This appeared evident based on the anterior pelvic tilt, overly developed quadriceps, back and shoulder muscles, and conversely the underdeveloped hamstrings and obliques. Based on these findings, it was valuable to use PRI techniques, as they served to get the pelvis/ribcage relationship closer to neutral. Neutrality in the pelvis/ribcage, according to the PRI hypothesis of the left anterior interior chain right brachial chain pattern, can create greater freedom of movement, or a greater ease of movement (5). Moreover, a neutral pelvis is one that can tilt anteriorly and posteriorly, internally and exteriorly rotate, and oscillate from left to right.

Based on this hypothesis and the assessment results, the first 2 – 4 weeks of training were focused on developing a better neuromuscular connection to the IOs/TAs, hamstrings, and adductors and incorporating that into sprinting. So, to start, the athlete was assigned two PRI techniques to begin addressing the lack of connection to the IO/TA, hamstrings, and adductors. Admittedly, there is minimal research of using PRI in athlete training programs and this topic could use further study. As far as sprint sessions, there were two types: a linear day and change of direction day. Linear days were focused on downward forces, mid-foot strike to train rate of force production (RFD) and maximize the stretch-shortening cycle, band-resisted bounds and running drills, and rib/pelvis position. Change of direction days were focused on lateralization of the hips (attaining femoral acetabular internal rotation) under load, rotational capacity, and loaded deceleration to unloaded accelerations.

For the second month, the high-intensity gym sessions focused on integrating a combination of strength, power, and speed exercises, still incorporating PRI techniques. There was also at least one sprint training day, if timing with competition allowed. Training variables were carefully evaluated and adjusted such as force, power, and velocity during gym sessions, along with work to rest ratios to ensure the athlete did not overtrain (6). Additionally, to enhance strength improvements, the percent of one-reptition maximum (1RM) needed to be around 80 – 85%. With such high intensities, training volume was maintained at a low level, such as 8 – 10 sets of total work in a gym session or no more than 10 bouts of sprint and moderate- to high-intensity running, while providing enough stimulus to elicit improvements in RFD and running economy (10).

As for power movements (Olympic-style movement derivatives and plyometrics), these were performed at a similarly low-volume repetition range and low- to moderate-intensity of 50 – 70% 1RM, working on high velocity and RFD (6). An additional component to these power movements was utilizing reaction. A loud clap or yelling "up" was used for some of the movements to work on improving reaction times and simultaneous isometric strength, depending on the movement. For speed training, band-resisted drills, wicket runs, plyometrics, medicine ball throwing exercises, and curved-treadmill intervals were all used to continue to work on speed.

For the third month, there was more emphasis on power and speed with less focus on strength. This month had the heaviest competition schedule. Because of this, the training layout changed dramatically. Mostly, there was only time for one gym session per week. In this session, strength training was usually just two sets of sub-maximal output, usually completing each set with a two-repetition reserve to avoid excess fatigue. Training became focused on Olympic-style movements, weighted plyometrics, and short sprints. As for the other two training sessions during the week, they were all about active recovery, light anaerobic work, and continuing to work on the weaknesses mentioned above.

CONCLUSION

By the end of the season and after almost three months of training to increase speed, there was a significant impact overall, both objective and subjective. Speed was recorded for the 10-yd and 40-yd sprints approximately every 30 days, and 10-yd splits of the 40-yd sprint in the second and third test day, all using hand times. There was some inconsistency in the number of runs on the testing days due to fatigue, but there was enough data to create averages and standard deviations for more accurate recording of progress.

Subjectively, the athlete reported much higher recruitment of their posterior chain musculature. The athlete also reported that overall movements became more fluid, easier, and lighter. Based on the objective PRI parameters, hip extension doubled to about 60º on both legs, the Ober's test became positive (indicating better adduction) on the right side and almost positive (adduction to body midline) on the left side. As for the GH-IR, that too saw improvement on the right side. All of these contributed to the athlete reporting an overall lower intensity of back pain (from a consistent 8/10 down to 3/10), as well as less quadriceps soreness. However, the athlete did report more hamstring soreness, which is likely due to better recruitment. Also, since they began prioritizing sleep more, they began to average 6 – 7 hr per night, aiding in their recovery.

In conclusion, this athlete appeared to improve from the training program. Their program had daily monitoring of energy level and psychological states. The sessions were scheduled based on competition and modified for the needs of the individual athlete.

TABLE 3. LINEAR ACCELERATION EXAMPLE

EXAMPLE OF A LINEAR ACCELERATION WORKOUT FOR 1 HR		
Warm-up	20 min	Running warm-up including but not limited to skips, hop drills, cycling drills, and sprints (rest as needed)
RFD	5 – 10 min	Jumping up stairs 2 – 3 sets each: Max # of stairs/jump for 1 flight, Pogos up 2 stairs x 8, 1L Hops x 8/side (Work:rest 1:12-15)
Speed	10 – 12 min	2 – 3 sets of each: Band Resisted 3 – 5 step drives, 5 – 20-yd sprints, Band Resisted High Knees and Cycles. (Work:rest 1:12-15)
Metabolic Training	10 – 15 min	Curved-Treadmill Running: 1x40 s at 75%, 1x30 s at 75%, 1x20 s at 85% (Work:rest 1:5-6)

TABLE 4. 3-MONTH TRAINING PROGRESSION

MONTH	TRAINING FOCUS
1st Month	PRI techniques, training foot strike (RFD), and hip projection, loaded hip hinging, lateral hip movements
2nd Month	Acceleration (up to 15 yd), reaction time,strength training, olympic weightlifting derivatives, vertical hip movements, PRI techniques
3rd Month	Acceleration (up to 15 yd), top speed mechanics of 75 – 85% pace curved-treadmill (10 – 40 s), strength and power training, plyometrics, PRI techniques

They had tailored PRI techniques to improve mobility, low-back pain, and neuromuscular connections. Training sessions were programmed around maximum force production—all the while minimizing injury risk. These considerations could be applied for training a similar population or clients with similar goals. More research is needed to determine the effectiveness of this specific protocol, but based on personal observation it appears potentially effective if applied properly by a certified professional.

REFERENCES

1. Chittenden, K. How to be an evidence-based fitness professional. *Personal Trainer Quarterly* 6(2): 20-22, 2019.

2. Favero, T, and White, J. Periodization in college soccer. *Strength and Conditioning Journal* 40(3): 33-44, 2018.

3. French, D. Adaptations to anaerobic training programs. In: Haff, GG, Triplett, TN (Eds), *Essential of Strength and Conditioning*. (4th Ed.) Champaign, IL: Human Kinetics; 87-113, 2016.

4. Gamble, P. Periodization of training for team sports athletes. *Strength and Conditioning Journal* 28(6): 56-66, 2006.

5. Jackson, L, Purvis, J, and Brown, T. The effects of postural and anatomical alignment on speed, power, and athletic performance in male collegiate athletics: A randomized controlled trial. *The International Journal of Sports Physical Therapy* 14(4): 623-636, 2019.

6. Kirby, T, Erickson, T, and McBride J. Model of progression of strength, power, and speed training. *Strength and Condition Journal* 32(6): 86-90, 2010.

7. Turner, A. The science and practice of periodization: A brief review. *Strength and Conditioning Journal* 33(2): 34-46, 2011.

8. Vitale, KC, Owens, R, Hopkins, SR, and Malhotra, A. Sleep hygiene for optimizing ecovery in athletes: Review and recommendations. *International Journal of Sports Medicine* 40(9): 535-543, 2019.

9. Walker, A, McFadden, B, Sanders, D, Rabideau, M, Hofacker, M, and Arent, S. Biomarker response to a competitive season in Division I female soccer players. *The Journal of Strength and Conditioning Research*. 33(10): 2622-2628, 2019.

10. Wing, C. In-season strength and power training considerations for professional soccer teams competing within national level competition. *Strength and Conditioning Journal* 40(3): 12-22, 2018.

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TIME-EFFICIENT TRAINING APPROACH AS A SOLUTION TO SEDENTARY OCCUPATIONAL HEALTH RISKS

IAN BONDER, MS, CSCS,*D, ANDREW SHIM, EDD, CSCS,*D, AND MARC TANGEMAN, MS, CSCS

INTRODUCTION

Today's workforce has become increasingly sedentary in comparison with past generations (42). Frequently reported obstacles to achieving recommended amounts of physical activity include poor or insufficient guidance on how to exercise, lack of social support and competence/confidence in physical abilities, poor or limited access to facilities in safe areas, fear of injury, and lack of time (18,20,44). The most often reported obstacle to achieving recommended levels of physical activity is lack of time. Populations reporting time constraints as a barrier to physical activity includes college, nursing, and medical students (5,19), working adults (18), emergency medical services employees (37), and healthcare occupations (13). In addition, sedentary occupations are a contributor to physical inactivity. As defined by the United States Department of Labor's Dictionary of Occupational Titles, "Sedentary work involves sitting most of the time, but may involve walking or standing for brief periods of time," (40). Furthermore, sedentary jobs may entail those employees who exert up to 10 lb of force for up to 1/3 of their workday (40). Physical inactivity and sedentary behavior traits are noted as the fourth leading cause of mortality and ranked 11th in terms of disease risk across the lifespan, worldwide (43). In 2010, approximately 3.2 million deaths were attributable to physical inactivity and low levels of physical activity (23). A 2014 study by Clemes et al. concluded that as much as 71% of study participants spent their workday in a sedentary state (8). Moreover, the cumulative sedentary behavior by the study participants on non-workdays has the potential to lead to further health complications. Table 1 provides a summary of commonly diagnosed health consequences as a result of physical inactivity from several studies (3,7,9,24,30,31).

TABLE 1. COMMON HEALTH CONSEQUENCES AND PHYSICAL AILMENTS IN SEDENTARY OCCUPATIONS (3,7,9,24,30,31)

HEALTH CONSEQUENCES
• Metabolic syndrome – comprised of: » Insulin resistance » Elevated triglyceride and blood glucose levels » High blood pressure » Abdominal obesity
• Type 2 diabetes
• Several types of cancer
• Stroke
• Coronary heart disease
• Increased risk of cardiovascular disease
• Shortened life expectancy
• Depression
• Neck, shoulder, and low-back pain
• Overweight/obesity
• Sarcopenia
• Decreased VO_2max

The 2011 American College of Sports Medicine (ACSM) position statement calls for American adults to complete at least 150 min of moderate physical activity per week or a minimum of 75 min of vigorous intensity exercise per week (12). Furthermore, it is recommended that at least 30 min of physical activity be performed 3 – 5 days per week depending on exercise intensity level (12). Additionally, resistance training is recommended at a minimum of 2 – 3 days per week, targeting all major muscle groups (12). Despite the physical activity guidelines that have been set forth for adults, many are not achieving the benchmarks listed. Survey results published in 2018 from nearly 480,000 adult respondents (ages 18+) indicated that approximately 16% completed the recommended amounts of aerobic and resistance exercises, 23.7% completed solely aerobic activity, and 4.5% completed only resistance training (45).

As a solution, the concept of time-efficient training may be a viable option for busy working adults who experience time as a barrier to exercise. Time-efficient training sessions are comprised of bilateral, multi-joint, compound movements, exercise-specific warm-ups with minimal focus on static stretching, and the optimization of intensity, volume, frequency, and volume-load per workout (20). Moreover, improved cardiovascular health and increased calorie expenditure may be attained in a time-efficient manner via the use of high-intensity interval training (HIIT) implemented with several modes of aerobic endurance exercise (25). HIIT is characterized by multiple, repeated high-intensity intervals of >90% VO_2max, focused on utilizing W:R ratios of 1:1 to 1:8 and virtually any mode of aerobic endurance exercise (25,28). Regarding training frequency, the use of several short training sessions is recommended, if possible. Cuthbert et al. supports the idea of shorter training sessions by way of a division of total planned weekly training volume across more frequent workouts throughout the week (10). Ultimately, the use of time-efficient training methods to achieve recommended physical activity levels may be obtained through less frequent traditionally structured training sessions (approximately 45 min) or by way of shorter (approximately 15 – 30 min) more frequent workouts (10,23,32).

BENEFITS OF TIME-EFFICIENT TRAINING

Dividing total daily training volume across multiple, more frequent workouts promotes improvements in numerous physiological qualities. Bonder et al. noted improvements in lower-body strength via the use of three 15-minute training sessions per week for four weeks within active law enforcement officers, achieving an average increase of 4.5% weight lifted in the hex-bar deadlift three repetition-maximum (3RM) (6). According to Fyfe et al., the maintenance or improvement of previously acquired levels of muscular strength, through minimal "doses" of resistance training, can be beneficial in promoting improvements in quality of life and independence thus preserving functional capabilities across the lifespan (10). In addition, Cuthbert et al. indicated that populations with prior resistance training experience may improve

levels of strength through fluctuations in volume and intensity prescriptions over the course of shorter more frequent workouts (10). A narrative review by Iversen et al. concluded as few as four sets per muscle group per week, with the use of weights ranging in intensity from 6 – 15 RM, may yield improvements in both muscular hypertrophy and strength (20). Thus, a focus on increasing skeletal muscle tissue, within reason, may be beneficial to maintain or improve strength, minimize the atrophy process of type II muscle fibers, blunt the potential loss of strength, and improve body composition, particularly in populations with minimal resistance training experience (10,14,38). Lastly, research by Häkkinen and Kallinen with female athletes noted statistically significant adaptations in neuromuscular functioning ($p < 0.01$), suggesting the potential to improve muscular power output (16).

Regarding cardiovascular health and muscular endurance, in a study among military personnel, Kilen et al. noted improvements in the "micro-training" group in both areas (22). Their "micro-training" group was comprised of 21 subjects that completed nine 15-minute training sessions per week while the "classical" training group completed three 45-minute training sessions per week. Specifically, the micro-training group experienced a 6.5% increase in peak oxygen uptake (measured in mL•min-1) during an incremental incline treadmill running test set at a fixed speed along with an approximate 9% improvement in number of lunges performed in two minutes in comparison with the "classical" training group. Schleppenbach et al. noted HIIT, specifically speed interval training (SIT), displays the potential to improve individual calorie consumption during the workout for both regular exercisers and sedentary individuals, leading to potential improvements in body composition (32). Regular exercisers were found to expend approximately 30 more calories per SIT session when compared to those individuals utilizing circuit training. Additionally, sedentary individuals had a caloric expenditure of approximately 11 more calories during SIT versus circuit training. Vaara et al. suggest improvements in muscular endurance have an inverse relationship with elements of metabolic syndrome including triglyceride levels, low-density lipoprotein (LPL), cholesterol, blood glucose, and high blood pressure along with a positive association with high-density lipoprotein (HDL) cholesterol (41). Heightened levels of muscular endurance also displayed a negative relationship with cardiovascular risk factors. Table 2 summarizes the physiological benefits that have been reported with the implementation of time-efficient training methods.

TABLE 2. SUMMARY OF POTENTIAL PHYSIOLOGICAL HEALTH BENEFITS VIA TIME-EFFICIENT TRAINING (6,10,11,16,20,22,32)

HEALTH BENEFITS
• Improvements in: » Upper- and lower-body strength » Muscular hypertrophy » Muscular power via adaptations in neuromuscular functioning » Cardiovascular health » Muscular endurance » Body composition via increased calorie expenditure

FOUNDATIONS OF TIME-EFFICIENT TRAINING

There are three main components that must be adhered to in order to derive the most benefit from time-efficient workouts. Namely, the structure and length of the warm-up, proper exercise selection, and rest period length. Each component is further elaborated on below.

WARM-UP STRUCTURE

A warm-up is often performed with the intent of preparing the individual for the upcoming workout and decreasing the likelihood of injury (21). In addition, the length of a warm-up is typically 5 – 15 minutes and progresses from general to specific movement patterns, relative to the upcoming training (1). The use of dynamic specific warm-ups prior to exercise are indicated to promote optimal strength and power output during training, thereby optimizing overall performance (26). In order to utilize available time, the use of a specific warm-up is recommended, prescribing submaximal loads of the upcoming exercise(s), due to minimal evidence supporting the use of a general warm-up (20). When preparing to undertake aerobic endurance exercise, such as with interval training or HIIT workouts, a gradual progression from walking to a full run over the course of 10 – 15 min is recommended (25).

EXERCISE SELECTION

While a wide array of exercises are available to choose from when designing a workout routine, those exercises including the greatest amount of musculature and connective tissue while prioritizing multiple joints should be selected. Despite the relative ease associated with learning single-joint movements, multi-joint movements should take precedent as they allow for the greatest amount of musculature to be stimulated during training (20). Furthermore, bilateral exercises (those movements utilizing both sides of the body at the same time) should be prioritized in time-efficient training programs as unilateral exercises (movements utilizing one side of the body at a time) may take more time to perform, leaving little time to complete supplementary exercises (20). Should the goal of the workout be focused on unilateral training, the concept of a "split routine" may be utilized to train different muscles and groups of muscles on different days of the week (35). When implementing interval and HIIT style training, the use of several modes of aerobic endurance exercise may be selected (25).

REST PERIOD LENGTH

Perhaps the most notable component of a time-efficient training program is the amount of inter- and intra-set rest to observe while exercising. The common theme with each of the methods to be described herein is the manipulation of rest period length. By way of decreasing allotted rest time, pairing exercises of opposing agonist and antagonist muscle groups, different regions of the body, or providing intra-set rest, downtime between movements may be minimized. A systematic review by Grgic et al. proposes that untrained individuals may benefit from rest intervals of less than 60 s in length to improve strength measures, while trainees with prior resistance training experience may necessitate the need for rest intervals lasting two minutes or longer (15). When the

focus of training is to improve cardiovascular health, interval and HIIT training may be implemented by following pre-determined work-to-rest ratios (W:R) from 1:1 to 1:8 using intensities of more than 90% VO_2max (25,28). The use of short intervals of 45 s, and long intervals of 2 – 4 min, may also potentially be used dependent on the physiological adaptation being sought and time available to train (28). As an investigation from Hoare et al. indicated that 50% of inactive adults listed "lack of time" as the most common barrier to achieving recommended amounts of weekly exercise, the use of rest intervals not exceeding two minutes is paramount when time is of the essence (18).

TIME-EFFICIENT TRAINING METHODS

To maximize time available to exercise, the use of several different training methods may be employed. Specifically, the choice of method utilized should be appropriate to match the individual's desired outcomes (e.g., muscular strength, power, endurance, hypertrophy, cardiovascular benefits). Most notably, strict and minimal rest period times should be utilized.

Potential methods to optimize training time include the use of supersets, compound sets, rest-pause training, resistance circuit, interval training, and HIIT. The use of supersets involves selecting two exercises of opposing muscle groups (agonist-antagonist) and performing them back-to-back, with no rest between sets (20,29). Examples of types of pairings include anterior-posterior movements, upper- and lower-body exercises, and pushing-pulling selections. Findings from Iversen et al. (20) suggest that an 8 – 12 RM loading scheme, with each exercise performed to muscular failure, be employed to maximize time-efficiency when prescribing supersets (21). The use of compound sets involves the same repetition, set, and rest period scheme as supersets, except the two exercises performed back-to-back are to target the same muscle group (35). In terms of efficiency, the primary drawback with using this method is that only one group of muscles or pattern of movement can be trained concurrently, limiting its efficacy in providing a whole-body stimulus for those individuals with minimal time and days to train during their week (20). Thus, the use of compound sets is suggested solely for those individuals able to dedicate themselves to several workouts per week. Utilization of rest-pause training involves performing multiple sets at submaximal intensities (< 80% 1RM), with each set being performed to muscular failure until a pre-determined number of repetitions has been completed (20). Unique to rest-pause training, the use of brief (20 – 30 s) inter-set rest periods follows the end of each set and prior to beginning the next. Prestes et al. (27) demonstrated that use of the rest-pause method in an experimental group (n=9) with a goal of 18 total repetitions per exercise showed similar results to that of a traditional, multiple set training group (n=9) performing 3 sets of 6 repetitions at 80% 1 RM with 2-min rest periods between sets. Both the rest-pause and traditional training groups utilized a variety of upper and lower body exercises focused on muscular strength. In addition, the experimental group utilizing the rest-pause method experienced greater improvements in muscular hypertrophy and endurance when compared with the traditional, multiple sets training group. As a result, this type of training may be particularly suitable to elicit improvements in muscular hypertrophy, strength, and endurance. Ultimately, due to the high intensity of this training technique, it is recommended for implementation with those individuals having prior resistance training experience (20).

In addition, the use of circuit resistance training may be advantageous when the goal is to promote improvements in muscular endurance and body composition by way of reduced body mass and body fat percentage (4,35,36). Moreover, interval training and HIIT may be beneficial to elicit improvements in cardiovascular health, aerobic endurance, individual recovery oxygen consumption levels, and body composition (2,25,32). While the classification of training styles may often be used interchangeably, the difference lies in the amount of rest prescribed with each type of training. Circuit training is performed with minimal to no rest between exercises while interval training and HIIT utilizes predetermined W:R ratios to elicit specific adaptations in the body's bioenergetic pathways including phosphagen, glycolytic, and oxidative systems (17). Alternatively, HIIT utilizes repeated high-intensity intervals of more than 90% VO_2max, with W:R ratios of 1:1 to 1:8 and virtually any mode of aerobic endurance exercise (25,28). Ultimately, HIIT training sessions may last between 5 – 30 min dependent upon the client's ability level and current aerobic training foundation (25). Tables 3 – 7 provide sample time-efficient training programs utilizing the various methods discussed to improve muscular strength, hypertrophy, power, endurance, and cardiovascular health.

TABLE 3. STRENGTH PROGRAM VIA REST-PAUSE METHOD

STRENGTH FOCUS
Warm-Up: Barbell complex: standing shoulder press – RDL – bent-over row – front squat 2 x 5 each movement (movements performed in succession with no rest between each) Front squat at 80% 1RM, goal = 18 total Repetitions (rest-pause method) Warm-up set: 5 – 6 repetitions at 50% 1RM Set 1: 6 repetitions (20 s rest) Set 2: 5 repetitions (20 s rest) Set 3: 4 repetitions (20 s rest) Set 4: 3 repetitions Hex bar deadlift at 85% 1RM: 3 x 5 – 6 repetitions (2 min rest between sets) Barbell RDL: 3 x 5 – 6 repetitions (2 minrest between sets) Dumbbell side lunges: 3 x 5 – 6 repetitions each leg (2 min rest between sets)

TABLE 4. HYPERTROPHY PROGRAM VIA SUPERSETS

HYPERTROPHY FOCUS
Warm-Up: (Perform exercises successfully; no rest between sets) Bodyweight push-ups: 2 x 10 repetitions Suspension trainer rows: 2 x 10 repetitions Intensity of each lift > ~30%1RM; intensity and volume will have an inverse relationship (33) **Superset 1:** (2 min rest after completing each pair of exercises) Dumbbell shoulder press: 3 x 8 – 12 repetitions; 3 x 5 – 30+ repetitions Lat pulldowns: 3 x 8 – 12 repetitions; 3 x 5 – 30+ repetitions **Superset 2:** (2 min rest after completing each pair of exercises) Dumbbell goblet squat: 3 x 8 – 12 repetitions; 3 x 5 – 30+ repetitions Dumbbell RDL: 3 x 8 – 12 repetitions; 3 x 5 – 30+ repetitions **Superset 3:** (2 min rest after completing each pair of exercises) Dumbbell bench press: 3 x 8 – 12 repetitions; 3 x 5 – 30+ repetitions Seated cable row: 3 x 8 – 12 repetitions; 3 x 5 – 30+ repetitions **Note: Use 8 – 12 repetition ranges for novice clients; 5 – 30+ repetition ranges for intermediate and advanced clients; classification of novice, intermediate, and advanced clients may be found in the* NSCA's Essentials of Personal Training (3rd ed.) *(18)*

TABLE 5. POWER PROGRAM

POWER FOCUS
Warm-Up: Bodyweight squats (x 10) – alternating lunge to in-step (x 20 yards) - jump squats (x 5) – pogo jumps (x 10 yards) 2 sets Squat jumps (in place): 5 x 8 – 12 (2 min rest after each set) Overhead medicine ball throw (light to moderate weight): 3 x 3 – 6 (2 min rest after each set) Mid-thigh hang clean: (2 min rest after each set) Warm-up set 1: 4 – 5 repetitions at 50% 1RM Warm-up set 2: 2 – 3 repetitions at 65% 1RM Sets 3 – 8: 2 repetitions at 80 – 90% 1RM

TABLE 6. MUSCULAR ENDURANCE PROGRAM VIA CIRCUIT RESISTANCE TRAINING

MUSCULAR ENDURANCE FOCUS
Warm-Up: Jog (1 lap) – bodyweight squats (x 10) – suspension trainer rows (x 10) – walking lunges (x 20 yards) – push-ups (x 10) Circuit (3 total rounds with 15 repetitions/exercise; alternate upper- and lower-body movements; weights used < 60% 1RM; 30 s rest after completing each exercise): Dumbbell goblet squat Seated dumbbell shoulder press Seated hamstring curl machine Medicine ball slams Dumbbell calf raises Dumbbell bench press Jump rope (20 – 30 s) Resistance band low row Dumbbell farmers carry (20 yards)

TABLE 7. CARDIOVASCULAR HEALTH PROGRAM VIA HIGH INTENSITY INTERVAL TRAINING (HIIT)

CARDIOVASCULAR HEALTH/AEROBIC ENDURANCE FOCUS
Warm-Up: 5-min walk to 5-min light jog to 5-min run Short interval training: 10 – 15 min total 30-s sprint (at >90% VO_2max) interspersed with 30 s of low-intensity recovery jogging intervals (W:R = 1:1) Long interval training: 30 – 45 min total Stair climber 2 – 4 min intervals (at >90% VO_2max) interspersed with 2 – 4 min low-intensity recovery intervals (W:R = 1:1) *NOTE: The Long Interval Training example has been included for use only as an option when an individual has more time to dedicate to training.

CONCLUSION

Lack of time is often the primary obstacle to inactive, sedentary adults achieving recommended amounts of weekly physical activity. Furthermore, a broad spectrum of occupations and career paths lend themselves to promoting sedentary behavior traits. In turn, physical inactivity may eventually lead to an increased risk and incidence of numerous health consequences and physiological ailments. The foundations and benefits of time-efficient training methods have been presented as a viable option to combat physical inactivity associated with sedentary occupations. In conjunction with the supervision of a certified personal trainer or strength and conditioning coach, the methods discussed herein may be implemented to confer a variety of overall health and physiological improvements while minimizing the time necessary to dedicate to training.

REFERENCES

1. Abad, C, Prado, M, Ugrinowitsch, C, Tricoli, V, and Barroso, R. Combination of general and specific warm-ups improves leg-press one repetition maximum compared with specific warm-up in trained individuals. *Journal of Strength and Conditioning Research* 25(8): 2242-2245, 2011.

2. Astorino, T, Allen, R, Roberson, D, and Jurancich, M. Effect of high-intensity interval training on cardiovascular function, VO_2max, and muscular force. *Journal of Strength and Conditioning Research* 26(1): 138–145, 2012.

3. Baradaran Mahdavi, S, Riahi, R, Vahdatpour, B, and Kelishadi, R. Association between sedentary behavior and low back pain; A systematic review and meta-analysis. *Health Promotion Perspectives* 11(4): 393–410, 2021.

4. Beqa Ahmeti, G, Idrizovic, K, Elezi, A, Zenic, N, and Ostojic, L. Endurance training vs. circuit resistance training: Effects on lipid profile and anthropometric/body composition status in healthy young adult women. *International Journal of Environmental Research and Public Health* 17(4): 1222, 2020.

5. Blake, H, Stanulewicz, N, and Mcgill, F. Predictors of physical activity and barriers to exercise in nursing and medical students. *Journal of Advanced Nursing* 73(4): 917–992, 2017.

6. Bonder, I, Shim, A, Lockie, R, and Ruppert, T. A preliminary investigation: Evaluating the effectiveness of an occupational specific training program to improve lower body strength and speed for law enforcement officers. *International Journal of Environmental Research and Public Health* 18(14): 7685, 2021.

7. Booth, F, Roberts, C, and Laye, M. Lack of exercise is a major cause of chronic diseases. *Comprehensive Physiology* 2(2): 1143–1211, 2012.

8. Clemes, S, O'Connell, S, and Edwardson, C. Office workers' objectively measured sedentary behavior and physical activity during and outside working hours. *Journal of Occupational and Environmental Medicine* 56(3): 298–303, 2014.

9. Csuhai, É, Nagy, A, Váradi, Z, and Veres-Balajti, I. Functional analysis of the spine with the Idiag SpinalMouse System among sedentary workers affected by non-specific low back pain. *International Journal of Environmental Research and Public Health* 17(24): 9259, 2020.

10. Cuthbert, M, Haff, G, Arent, S, Ripley, N, McMahon, J, Evans, M, and Comfort, P. Effects of variations in resistance training frequency on strength development in well-trained populations and implications for in-season athlete training: A systematic review and meta-analysis. *Sports Medicine (Auckland, N.Z.)* 51(9): 1967–1982, 2021.

11. Fyfe, J, Hamilton, D, and Daly, R. Minimal-dose resistance training for improving muscle mass, strength, and function: A narrative review of current evidence and practical considerations. *Sports Medicine (Auckland, N.Z.)* 52(3): 463–479, 2022.

12. Garber, C, Blissmer, B, Deschenes, M, Franklin, B, Lamonte, M, Lee, I, et al. American College of Sports Medicine position stand. Quantity and quality of exercise for developing and maintaining cardiorespiratory, musculoskeletal, and neuromotor fitness in apparently healthy adults: guidance for prescribing exercise. *Medicine and Science in Sports and Exercise* 43(7): 1334–1359, 2011.

13. George, L, Lais, H, Chacko, M, Retnakumar, C, and Krishnapillai, V. Motivators and barriers for physical activity among health-care professionals: A qualitative study. *Indian Journal of Community Medicine: Official Publication of Indian Association of Preventive and Social Medicine* 46(1): 66–69, 2021.

14. Granacher, U, Gollhofer, A, Hortobágyi, T, Kressig, R, and Muehlbauer, T. The importance of trunk muscle strength for balance, functional performance, and fall prevention in seniors: A systematic review. *Sports Medicine (Auckland, N.Z.)* 43(7): 627–641, 2013.

15. Grgic, J, Schoenfeld, B, Skrepnik, M, Davies, T, and Mikulic, P. Effects of rest interval duration in resistance training on measures of muscular strength: A systematic review. *Sports Medicine (Aukland, N.Z.)* 48(1): 137–151, 2018.

16. Häkkinen, K, and Kallinen, M. Distribution of strength training volume into one or two daily sessions and neuromuscular adaptations in female athletes. *Electromyography and Clinical Neurophysiology* 34 (2): 117-124, 1994.

17. Herda, T, and Cramer, J. Bioenergetics of exercise and training. In: Haff GG, Triplett NT, (Eds.), *Essentials of Strength Training and Conditioning*. (4th ed.) Champaign, IL: Human Kinetics; 59-60, 2016.

18. Hoare, E, Stavreski, B, Jennings, G, and Kingwell, B. Exploring motivation and barriers to physical activity among active and inactive Australian adults. *Sports (Basel, Switzerland)* 5(3): 47, 2017.

19. Hurley, K, Flippin, K, Blom, L, Bolin, J, Hoover, D, and Judge, L. Practices, perceived benefits, and barriers to resistance training among women enrolled in college. *International Journal of Exercise Science* 11(5): 226–238, 2018.

20. Iversen, V, Norum, M, Schoenfeld, B, and Fimland, M. No time to lift? Designing time-efficient training programs for strength and hypertrophy: A narrative review. *Sports Medicine (Auckland, N.Z.)* 51(10): 2079–2095, 2021.

21. Jeffreys, I. Warm-up and flexibility training. In Haff, GG, Triplett, NT, (Eds.), *Essentials of Strength Training and Conditioning*. (4th ed.) Champaign, IL: Human Kinetics; 318, 2016.

22. Kilen, A, Hjelvang, L, Dall, N, Kruse, N, and Nordsborg, N. Adaptations to short, frequent sessions of endurance and strength training are similar to longer, less frequent exercise sessions when the total volume is the same. *Journal of Strength and Conditioning Research* 29)Suppl 11): S46–S51, 2015.

23. Lim, S, Vos, T, Flaxman, A, Danaei, G, Shibuya, K, Adair-Rohani, H, et al A comparative risk assessment of burden of disease and injury attributable to 67 risk factors and risk factor clusters in 21 regions, 1990-2010: a systematic analysis for the Global Burden of Disease Study 2010. *Lancet (London, England)* 380(9859): 2224–2260, 2012.

24. Mackenzie, K, Such, E, Norman, P, and Goyder, E. Using co-production to develop "sit less at work" interventions in a range of organisations. *International Journal of Environmental Research and Public Health* 18(15): 7751, 2021.

25. Martino, M, and Dabbs, N. Aerobic training program design. In Schoenfeld, BJ, Snarr, RL (Eds.), *NSCA's Essentials of Personal Training*. (3rd ed.) Champaign, IL: Human Kinetics; 425-445, 2022.

26. McCrary, J, Ackermann, B, and Halaki, M. A systematic review of the effects of upper body warm-up on performance and injury. *British Journal of Sports Medicine* 49(14): 935–942, 2015.

27. Prestes, J, Tibana, R, de Araujo Sousa, E, et al. Strength and muscular adaptations after 6 weeks of rest-pause vs. traditional multiple-sets resistance training in trained Subjects. *Journal of Strength and Conditioning Research* 33 Suppl 1: S113–S121, 2019.

28. Reuter, B, and Dawes, J. Program design and technique for aerobic endurance training. In Haff GG, Triplett NT, (Eds.), *Essentials of Strength Training and Conditioning*. (4th ed.) Champaign, IL: Human Kinetics; 559-581, 2016.

29. Robbins, D, Young, W, Behm, D, and Payne, W. Agonist-antagonist paired set resistance training: A brief review. *Journal of Strength and Conditioning Research* 24(10): 2873–2882, 2010.

30. Rolland, Y, Czerwinski, S, Abellan Van Kan, G, Morley, J, Cesari, M, Onder, G, et al. Sarcopenia: Its assessment, etiology, pathogenesis, consequences and future perspectives. *The Journal of Nutrition, Health and aging* 12(7): 433–450, 2008.

31. Roomi, M, and Mohammadnezhad, M. Prevalence of metabolic syndrome among apparently healthy workforce. *Journal of Ayub Medical College, Abbottabad* 31(2): 252–254, 2019.

32. Schleppenbach, L, Ezer, A, Gronemus, S, Widenski, K, Braun, S, and Janot, J. Speed- and circuit-based high-intensity interval training on recovery oxygen consumption. *International Journal of Exercise Science* 10(7): 942–953, 2017.

33. Schoenfeld, BJ, Grgic, J, Van Every, DW, and Plotkin, DL. Loading recommendations for muscle strength, hypertrophy, and local endurance: A re-examination of the repetition continuum. *Sports* (Basel) 9(2): 32, 2021.

34. Schoenfeld, B, and Snarr, R. Resistance training program design. In: Schoenfeld BJ, Snarr RL, (Eds.), *NSCA's Essentials of Personal Training*. (3rd ed.) Champaign, IL: Human Kinetics; 393-424, 2022.

35. Sheppard, J, and Triplett, N. Program design for resistance training. In: Haff GG, Triplett NT, (Eds.), *Essentials of Strength Training and Conditioning*. (4th ed.) Champaign, IL: Human Kinetics; 439–470, 2016.

36. Sokoloski, M, Rigby, B, Bachik, C, Gordon, R, Rowland, I, Zumbro, E, and Duplanty, A. Changes in health and physical fitness parameters after six months of group exercise training in firefighters. *Sports (Basel)* 8(11): 143, 2020.

37. Supples, M, Rivard, M, Cash, R, Chrzan, K, Panchal, A, and McGinnis, H. Barriers to physical activity among emergency medical services professionals. *Journal of Physical Activity and Health* 18(3): 304–309, 2021.

38. Talar, K, Hernández-Belmonte, A, Vetrovsky, T, Steffl, M, Kałamacka, E, and Courel-Ibáñez, J. Benefits of resistance training in early and late stages of frailty and sarcopenia: A systematic review and meta-analysis of randomized controlled studies. *Journal of Clinical Medicine* 10(8): 1630, 2021.

39. Tataryn, N, Simas, V, Catterall, T, Furness, J, and Keogh, J. Posterior-chain resistance training compared to general exercise and walking programmes for the treatment of chronic low back pain in the general population: A systematic review and meta-analysis. *Sports Medicine - Open* 7(1): 17, 2021.

40. U.S. Department of Labor. *Dictionary of Occupational Titles* (4th ed. Rev. 1991) - Appendix C. U.S. Department of Labor; 1991.

41. Vaara, J, Fogelholm, M, Vasankari, T, Santtila, M, Häkkinen, K, and Kyröläinen, H. Associations of maximal strength and muscular endurance with cardiovascular risk factors. *International Journal of Sports Medicine* 35(4): 356–360, 2014.

42. van der Ploeg H, Møller S, Hannerz H, van der Beek A, and Holtermann A. Temporal changes in occupational sitting time in the Danish workforce and associations with all-cause mortality: results from the Danish work environment cohort study. *International Journal of Behavioral Nutrition and Physical Activity* 12: 71, 2015.

43. World Health Organization. *Global Health Risks: Mortality and Burden of Disease Attributable to Selected Major Risks*. World Health Organization; 2009.

44. Yarmohammadi, S, Mozafar Saadati, H, Ghaffari, M, and Ramezankhani, A. A systematic review of barriers and motivators to physical activity in elderly adults in Iran and worldwide. *Epidemiology and Health* 41: e2019049, 2019.

45. Zhao, M, Veeranki, S, Magnussen, C, and Xi, B. Recommended physical activity and all cause and cause specific mortality in US adults: Prospective cohort study. *BMJ (Clinical Research Ed.)* 370: m2031, 2020.

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