15th Congress of The Korean Society of Sarcopenia

2023년 대한근감소증학회
제15차 학술대회

| **일시** | 2023년 11월 18일(토)

| **장소** | 수원컨벤션센터 4층

| **평점** | 대한의사협회 6평점

대한근감소증학회
The Korean Society of Sarcopenia

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- 프로그램 -

08:50-09:00	Opening Remark		
	대학회장		
	Session I Research into Rejuvenating Aging Muscle: from Bench to Bedside 좌장: 원장원(경희의대), 김태년(인제의대)		
09:00-09:25	Integrative Bioengineering Tools to Diagnose and Attenuate Sarcopenia 장영목(Department of Biomedical Engineering, Emory Musculoskeletal Institute)	···	*3p*
09:25-09:50	Role of Resistance Exercise-Induced PPARβ on Muscle Protein Quality Control 고진호(연세원주의대)	···	*7p*
09:50-10:15	The Importance of Protein Ingestion and Physical Activity to Prevent Sarcopenia 임창현(Postdoctoral Fellow, Department of Kinesiology, McMaster University)	···	*9p*
10:15-10:25	Discussion		
10:25-10:40	Coffee Break		
	Session II 근감소증 실제 진단법(How to Set up Diagnostic Tools for Sarcopenia) 좌장: 박형무(그레이스병원), 김덕윤(경희의대)		
10:40-10:55	체성분측정 최신 지견 임재영(서울의대)	···	*13p*
10:55-11:10	복부CT를 이용한 근육량 측정 박효정(서울아산병원)	···	*15p*
11:10-11:25	외래에서 근감소증 진단과 치료 경험 최정연(분당서울대병원)	···	*19p*
11:25-11:40	Discussion		
	Session III Presidential Lecture 좌장: 장학철(서울의대)		
11:40-12:10	근감소증 진단기준: 현황과 전망 원장원(경희의대)	···	*23p*
	Luncheon		
12:10-12:20	총회		
	Poster Presentation Session (403호)		
13:20-13:40	Poster Presentation		
	Session IV 근감소증 국내 역학연구 활성화; 국민건강영양조사 자료 활용 좌장: 이윤환(아주의대), 하용찬(서울부민병원)		
13:40-14:00	노인노쇠코호트 소개 김미지(경희대학교)	···	*27p*
14:00-14:20	KoGES 연구자원 활용 이경호(국립보건연구원)	···	*31p*
14:20-14:40	국민건강영양조사 근감소증 조사 소개 오경원(건강영양조사분석과)	···	*35p*
14:40-15:00	국민건강영양조사 근감소증 관련 연구 안성희(인하의대)	···	*39p*
15:00-15:20	Panel Discussion 임재영(서울의대), 유준일(인하의대), 백지연(서울아산병원), 김은샘(아주대)		
15:20-15:40	Coffee Break		
	Session V 근감소증 중재 요법 좌장: 박세정(한국스포츠정책과학원), 이해정(가천대)		
15:40-16:05	Dietary Essential Amion Acids and Anabolic Resistance in Aging Muscle 김일영(가천의대)	···	*43p*
16:05-16:30	근감소증 예방과 치료를 위한 운동중재 이세원(인천대학교 체육학부)	···	*47p*
16:30-16:55	근감소증 환자의 재활 중재 유명철(경희의대)	···	*49p*
16:55-17:05	Discussion		
17:05-17:10	구연 및 포스터 시상		

소학회장

Session VI 일반 연제 발표

좌장: 황인규(중앙의대), 서대윤(인제대학교)

10:40-11:40	Paper Presentation		…	*56p*

Poster Presentation Session (403호)

13:20-13:40	Poster Presentation			

Session VIII 기초/중개 연구(Basic Research/Translational Research)

좌장: 류동렬(광주과학기술원), 송욱(서울대학교)

13:40-14:05	Significance of Cellular Senescence in Sarcopenia	강주희(인하의대)	…	*85p*
14:05-14:30	노화 세포 표적 발굴 및 제거의 최신 동향	김천아(한국생명공학연구원)	…	*87p*
14:30-14:55	Immunosenescence in Metabolic Liver Disease	이현승(충남의대)	…	*89p*
14:55-15:20	Discussion			
15:20-15:40	Coffee Break			

Session IX Muscle-Bone-Fat Crosstalk

좌장: 김태영(건국의대), 유준일(인하의대)

15:40-16:05	Bone and Muscle Interaction	김진우(을지의대 정형외과)	…	*93p*
16:05-16:30	Definition and Pathophysiology of Sarco–osteoporosis	전윤경(부산의대 내분비내과)	…	*97p*
16:30-16:55	Changes in Body Composition with Aging: Visceral Fat Obesity, Low Muscle Mass, and Myosteatosis	김홍규(울산의대 건강의학과)	…	*103p*
16:55-17:05	Discussion			

워크숍

Session X 근감소증 평가의 실제

좌장: 임재영(서울의대)

15:40-15:55	근력 측정의 실제	임승규(순천향의대)	…	*107p*
15:55-16:10	신체수행평가의 실제	지명기(분당서울대병원)	…	*111p*
16:10-16:25	체성분 분석의 결과 해석 및 활용	심가양(경희의대)	…	*117p*
16:25-17:05	평가 실습	김아셀(분당서울대병원), 지명기(분당서울대병원)	…	*121p*

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대학회장

Session I

Research into Rejuvenating Aging Muscle: from Bench to Bedside

좌장: 원장원(경희의대), 김태년(인제의대)

Curriculum Vitae

장영목

소속: Department of Biomedical Engineering, Emory Musculoskeletal Institute

| 학력사항 |

2008 Ph.D. University of Texas
Cell Biology (Biomedical Sciences)
Advisor: Holly Van Remmen

2003 M.S. University of Florida
Applied Physiology (Minor: Gerontology)
Advisor: Christiaan Leeuwenburgh

2000 B.S. Korea University

| 경력사항 |

2022–Pres. Associate Professor (Tenured),
Department of Orthopedics, School of Medicine
Wallace H. Coulter Department of Biomedical Engineering
School of Biological Sciences
Bioengineering Graduate, Program Faculty
Emory University School of Medicine & Georgia Institute of Technology

2021–Pres. Associate Professor, School of Bio Sci (Tenured), Georgia Institute of Technology

2016–2021 Assistant Professor, School of Biological Sciences, Georgia Institute of Technology

2014–2016 Assistant Professor, School of Applied Physiology, Georgia Institute of Technology

2012–2014 Research Faculty, Harvard University
GSK Principal Investigator, Harvard Stem Cell Institute

2010–2012 Postdoctoral Fellow, Dept of Stem Cell & Regenerative Biology, Harvard University

2008–2010 Postdoctoral Fellow, Barshop Institute for Longevity and Aging Studies

2004–2008 Research Assistant, Department of Cellular and Structural Biology, UTHSCSA

2004–2005 American Heart Association Predoctoral Fellow, AHA Florida Affiliate

2002–2004 Teaching Assistant, University of Florida

2001–2004 Research Assistant, Biochemistry of Aging Laboratory, University of Florida

Integrative Bioengineering Approaches to Rejuvenate Aging Skeletal Muscle

Department of Biomedical Engineering, Emory Musculoskeletal Institute
장영목

Age-related loss of muscle mass and function often referred to as sarcopenia dramatically affects the quality of life in the elderly population and predisposes them to an increased risk of morbidity, disability, and mortality. As the elderly population rapidly grows worldwide, the healthcare cost to treat sarcopenia and frailty-related is projected to grow exponentially in the next decades.

Muscle stem/satellite cells (MuSCs) play a central role in muscle regeneration, but their quantity and function decline with comorbidity of trauma, cachexia, aging, and muscle diseases. Although transplantation of MuSCs in traumatically injured muscle in the comorbid context of aging or pathology is a strategy to boost muscle regeneration, an effective cell delivery strategy in such contexts has not been developed. Thus, we engineered a synthetic hydrogel-based matrix with optimal mechanical, cell-adhesive, and protease-degradable properties that promotes MuSC survival, proliferation, and differentiation. Furthermore, we established a biomaterial-mediated cell delivery strategy for treating muscle trauma, where intramuscular injections may not be applicable. Delivery of MuSCs in the engineered matrix significantly improved in vivo cell survival, proliferation, and engraftment in non-irradiated and immunocompetent muscles of aged and dystrophic mice compared to collagen gels and cells-only controls. This platform may be suitable for treating craniofacial and limb muscle trauma, as well as post-operative wounds of elderly and dystrophic patients.

In the second part of the presentation, I will discuss how heterochronic parabiosis, in which young and aged animals are surgically attached to share circulation, and how exposure of aged muscle, to a “youthful”

systemic environment, reverse many indicators of age-related pathology and restores robust muscle regeneration after injury. I will also describe how we can integrate the organ-on-a-chip and functional biomaterials to mimic parabiosis and understand the systemic regulations of muscle aging and other muscle wasting conditions.

MEMO

Curriculum Vitae

고진호

소속: 연세원주의대

| 학력사항 |

2000 BS in Physical Education, Sejong University in South Korea
2004 MS in Physical Education, Keimyung University in South Korea
2010 Ph.D. in Physical Education, Keimyung University in South Korea

| 경력사항 |

2009 – 2012	Instructor in exercise physiology
2010 – 2012	Post Doc., Keimyung University in South Korea
2012 – 2016	Post Doc., Washington University School of Medicine in St. Louis, MO, USA
2016 – 2018	Research fellow in the Department of Endocrinology, Diabetes, Nutrition at Mayo Clinic, Rochester, MN, USA
2018 – 2021	Research Professor at Yeungnam University College of Medicine, South Korea
2021 – 2022	Research Professor at Gachon University College of Medicine, South Korea
2023 – current	Associate Professor at Yonsei University College of Medicine, South Korea

Role of Resistance Exercise-Induced PPARβ on Muscle Protein Quality Control

연세원주의대

고진호

Resistance exercise training (RET) is an effective countermeasure to sarcopenia, related frailty, and metabolic disorders. Here, we show that an RET-induced increase in PGC-1α4 (an isoform of the transcriptional co-activator PGC-1α) expression not only promotes muscle hypertrophy but also enhances glycolysis, providing a rapid supply of ATP for muscle contractions. In human skeletal muscle, PGC-1α4 binds to the nuclear receptor PPARβ following RET, resulting in downstream effects on the expressions of key glycolytic genes. In myotubes, we show that PGC-1α4 overexpression increases anaerobic glycolysis in a PPARβ-dependent manner and promotes muscle glucose uptake. Glucose metabolism is involved in protein quality control (PQC), moreover, RET and PGC-1α change gene expression that is related to autophagy and PQC in muscle and myotubes, respectively. These results provide a mechanistic link between RET and improved glucose metabolism, offering an important therapeutic target to counteract aging and inactivity-induced poor PQC, benefitting those who cannot exercise due to many reasons. Since PPARβ is a core factor that is induced by RET to regulate glucose metabolism, we believe that PPARβ regulates PQC in skeletal muscle. However, further studies are required to understand how RET-induced PPARβ regulates PQC in sarcopenia.

Curriculum Vitae

임창현

소속: Postdoctoral Fellow, Department of Kinesiology, McMaster University

| 학력사항 |

2005 – 2012 B.Sc. Health and Exercise science
Korea National Sport University, Seoul, South Korea

2012 – 2014 M.Sc. Exercise Physiology
Korea National Sport University, Seoul, South Korea

2014 – 2108 Ph.D. Exercise Physiology
Korea National Sport University, Seoul, South Korea

| 경력사항 |

2018 – Present Postdoctoral Research Fellow
Department of Kinesiology, McMaster University, Canada

The Importance of Protein Ingestion and Physical Activity to Prevent Sarcopenia

Postdoctoral Fellow, Department of Kinesiology, McMaster University

임창현

Aging is characterized by a progressive loss of integrity and function across various physiological systems, substantially increasing the risk for morbidity and mortality. A noticeable hallmark of aging physiology is the progressive decline in the size, quality, and function of skeletal muscle, known as sarcopenia. This decline leads to mobility limitations, chronic disease risk, and ultimately frailty. Developing clinically viable interventions to combat sarcopenia may be a key to promoting healthy independent aging.

Lifestyle-based interventions are among the most effective strategies to protect against the loss of skeletal muscle with aging. Physical activity is critical for enhancing mobility and increasing muscle mass in older adults. Typically, utilizing heavier loads (>70% of 1 repetition maximum) in resistance exercise is thought to increase muscle mass and muscular strength. However, our research, along with other studies, has shown that resistance exercise training with a high degree of effort that achieves, or comes close to, volitional muscular failure is sufficient to maximize muscle protein synthesis, leading to skeletal muscle hypertrophy or at least to mitigate of muscle loss, regardless of the load. To this end, lower-load resistance exercise training offers a suitable and possibly safer alternative to traditional resistance exercise training and may be preferable as it targets more of the physiological impairments in older individuals. Additionally, I will introduce a feasible and accessible exercise regimen, stair climbing, which has shown skeletal muscle micro-vascularization.

Dietary interventions play a crucial role in healthy aging, and protein ingestion provides the essential

substrates (i.e., amino acids) for maintaining or growing muscle mass with aging. Importantly, not all protein sources are equivalent in their ability to support muscle protein synthesis. Our studies revealed that collagen protein, which has limited essential amino acid profiles, did not induce any additional muscle protein synthesis in older adults. On the other hand, while plant-based protein is generally considered lower quality protein, fortification with leucine significantly improved its effect on muscle protein synthesis.

Thus, feasible physical activities (i.e., lower-load resistance exercise training and stair climbing) and proper protein ingestion with higher essential amino acids could be viable strategies to promote wellness at home by preserving or increasing muscle mass in aging individuals.

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대학회장

Session II

근감소증 실제 진단법
(How to Set up Diagnostic Tools for Sarcopenia)

좌장: 박형무(그레이스병원), 김덕윤(경희의대)

Curriculum Vitae

임재영

소속: 서울의대 분당서울대학교병원

| 학력사항 |

1994	서울대학교 의학과 졸업
1998	서울대학교 의학과 의학석사(해부학)
2004	서울대학교 의학과 의학박사(재활의학)

| 경력사항 |

2003 – 현재	서울대학교 의과대학, 분당서울대학교병원 교수
2013 – 2014	Vanderbilt University Medical Center, Stallworth Rehabilitation Hospital 연수
2008 – 2009	Harvard Medical School, Spaulding Rehabilitation Hospital 연수
2002 – 2003	서울대학교병원 촉탁교수(전임강사)
2002 – 2002	국립재활원 의무사무관
2000 – 2002	국립재활원 재활의학 전문의
1999 – 2000	화성군보건소 재활의학 전문의
1995 – 1999	서울대학교병원 재활의학 전공의

체성분 측정의 최신 지견

서울의대
임재영

체성분 분석은 건강과 질병에 미치는 영향을 평가하는데 있어서 점차 중요해지고 있다. 체성분 중 지방성분의 증가는 비만심혈관 질환의 위험 요인으로 중요하게 인식되어 왔고, 체성분의 제지방 성분(fat free mass, lean mass)은 골격근육량을 대변하며, 노인과 질병을 가진 환자들에게 있어서 건강에 영향을 미치는 중요한 역할을 한다. 노화와 질환에서 일어나는 체성분의 변화는 질병이환율, 장애, 건강 상태와 관련성을 갖는다. 특히 노쇠(frailty), 골격근의 위축, 근감소증(sarcopenia)은 노인에게 매우 흔한 노인성 질환으로 우리나라 건강수명을 위협하는 고질적인 문제이다. 이에 대한 예방과 치료, 재활은 초고령사회를 맞이하는 우리나라 보건의료의 주요 관심사이다. 따라서 체성분 분석을 통해 근육양을 측정하여 감소 유무에 따라 근감소증을 진단하는 노력이 계속되고 있다. 또한 근력과 신체수행평가 및 체성분 분석을 통해 근감소증에 대한 임상적 판단을 내리고, 필요한 중재들을 선택하여 결과를 검증하는 일련의 임상 적용 과정에서 체성분 변화의 정확한 측정은 필수불가결하다고 할수 있다.

본 리뷰에서는 체성분 분석 방법들과 이들의 장단점을 간단하게 비교하고, 이 중에 DEXA와 BIA를 중심으로 근감소증 진단을 위해 사용되었던 방법들을 고찰하고자 한다. 근감소증 진단을 위한 여러 임상 지침들에서 체성분 분석을 통한 사지 골격근육양의 조작적 정의 및 절단값 현황을 검토하고, 주요 논란과 체성분 분석 방법의 제한점들에 대해 정리할 것이다. 또한 근감소증 진단을 위한 체성분 분석법이 국내의 건강보험 체계에 적용되어온 과정과 최신 현황에 대해 살펴보고 미래 발전 방향에 대해 논의하고자 한다.

Curriculum Vitae

박효정

소속: 서울아산병원

| 학력사항 |

2007 – 2013 BD, University of Ulsan Collage of Medicine, Ulsan/Seoul
2015 – 2017 Md, University of Ulsan Collage of Medicine, Seoul
2018 – 2020 Phd, University of Ulsan Collage of Medicine, Seoul

| 경력사항 |

- Clinical Assistant Professor, Department of Radiology, Asan Medical Center, Seoul, Korea
- Member of Korean Liver Cancer Study Group, Korean Radiological Society, Korean Society of Abdominal Imaging, Korean Society of Magnetic Resonance Imaging, Korean Society of Ultrasound in Medicine, and Radiology Society of North America

복부 CT를 이용한 근육량 측정

서울아산병원
박효정

복부 CT는 환자의 진료 과정에서 질병의 진단 및 치료 평가 등을 위해 촬영되며 이러한 CT 데이터를 이용하여 여러가지 추가 정보를 획득할 수 있다. 즉, 추가 radiation exposure 없이 복부 CT를 통해 스캔된 복부 단면의 근육량과 지방량을 정량화하여 체성분 평가(골다공증, 근육량, 지방량, 근지방증, 골근감소증 등) 또는 심혈관 대사평가(동맥경화 평가, 지방간 평가 등) 등을 수행할 수 있다. 대한골다공증학회에서는 2021년에 "골절을 동반한 골다공증의 진료지침"에서 이러한 "기왕 CT (opportunistic CT)"의 잠재력을 언급하고 있다. 최근 연구들은 복부 CT 데이터를 활용하여 근육량과 지방량을 측정하고 근감소증을 평가하는 것 외에도 근육의 질(quality)을 반영하는 근지방증 (myosteatosis)을 정량적으로 평가할 수 있음을 보여주었다. 이러한 정량적인 지표를 인공지능을 통해 쉽고 빠르게 측정할 수 있으며, 여러 상용 제품들이 있다.

이렇게 CT 데이터를 이용하여 체성분을 측정하고 근감소증을 평가할 수 있으나, 여전히 논의가 필요한 몇가지 이슈들이 있다. 첫째, 근감소증의 정의에 대한 consensus가 부족하다. EWGSOP2에 따르면 T score -2.0을 기준으로 근감소증을 진단하는 것을 권장하고 있는 데 반해, 유럽 등에서는 성별과 BMI를 기반으로 하는 기준을 제시하였다. 체성분은 인종에 따라서 차이가 있을 수 있기 때문에 한가지 방법으로만 근감소증을 평가하는 것은 부적절하며, 각 인구 그룹에 적합한 충분히 검증된 기준이 필요하다. 둘째, CT 획득 방법에 대한 consensus가 부족하다. CT의 기술적 측면(tube current 또는 slice thickness 등), 영상 재구성 방법(filtered back projection 혹은 iterative reconstruction 등), 그리고 조영제 사용 여부에 따라 얻어지는 CT 영상의 density는 달라질 수 있으며, 기본적으로 CT를 이용한 측정은 조직의 density를 기반으로 한다는 점을 고려시 이러한 다양성으로 인해 측정 결과에 변동성이 발생할 수 있다는 우려가 있고 아직 이 문제에 대한 충분한 연구는 이루어지지 않은 상태이다. 셋째, 측정 방법에 대한 consensus가 부족하다. 현재까지 복부 CT를 이용한

근육량 측정시 3번째 요추(3rd lumbar vertebra; L3) 레벨의 단면을 사용하는 것이 표준 방법으로 여겨져 왔으나 최근에는 L1 레벨이나 허벅지 레벨에서의 측정 방법 또한 제안되었고, 어떤 방법이 더 정확한지에 대한 논의가 진행 중이며, 모든 skeletal muscle (abdominal wall muscle, psoas muscle, paraspinal muscle)을 측정해야 할지 혹은 psoas muscle만 측정해야 할지에 대해서도 consensus가 부족한 상태이다. 따라서 이러한 문제들은 앞으로도 계속해서 연구와 논의가 필요하다.

MEMO

Curriculum Vitae

최정연

소속: 분당서울대학교병원

| 학력사항 |

2006 – 2012 서울대학교 의과대학 의예과/의학과 학사과정
2015 – 2018 서울대학교 의과대학 의학과 석박 통합 과정(임상약리학)
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2012 – 2013 서울대학교병원 인턴

외래에서 근감소증 진단과 치료 경험

분당서울대학교병원
최정연

2023년 기준 우리나라 올해 노인 인구는 950만명으로 노인 인구는 전체 인구의 18.4%를 차지하고 있다. 2025년에는 20.6%가 되어 초 고령 사회가 되고, 2050년에는 40%를 넘길 것이며, 2070년 즈음에는 OECD에서 가장 고령화된 국가가 될 예정이다. 노년기에는 질병이 많아지고 많아진 질병 때문에 약을 많이 먹게 되며(다약제, 부적절 약제) 기력저하, 식욕저하, 신체활동 저하 때문에 근감소증, 노쇠가 발생하면서 스트레스에 대응하는 능력이 감소하게 되며 기능이 저하된다. 반대로 점점 핵가족화, 고령자가구가 늘어나고 있기 때문에 노인들은 경제적인 문제, 외로움, 우울, 불안에 시달리고 재가를 위해 신체적/인지기능적 기능 유지가 더욱 절실해지고 있다.

근감소증의 증상 호소는 주로 최근의 급격한 체중 감소, 계단 오르기, 무거운 물건 들어올리기 등 예전에 하던 일을 수행하기가 힘들어지는 것, 최근에 반복적으로 낙상을 하는 것, 걷기가 버거워지는 것, 기운 없음, 피곤함 등 다양한 증상을 호소한다. 건강수명, 건강하게 살 것으로 기대되는 기간으로 서의 수명과 기대수명이 약 10년 정도 차이 나는 것을 고려할 때, 근감소증에 대하여 잘 조기에 잘 대처하는 것이 중요 하다.

근감소증은 그 중요성이 강조되어 관련 연구도 점점 증가하고 있다. 근감소증은 2017년에 ICD-10-CM에 등재되어 질병으로 서의 중요성을 인식하고 있으며 향후 다양한 질환의 악화, 기능 저하, 장기요양시설/병원 입소, 사망과의 연관성이 높다는 것이 알려져 있다. 근감소증의 진단은 아시아가이드라인에 따르면 case finding을 위해SARC-F를 시행하고 SARC-F 10점 만점에 4점 이상인 경우, 근력 혹은 근기능을 측정한다. 근력과 근기능 둘 중에 하나에 이상이 있으면 possible sarcopenia 로 lifestyle modification을 진행하고 진단을 위해 refer 하도록 추천한다. 정확한 진단을 위해서는 근력과 근기능, 근육량 3가지를 측정하여 근감소증 여부를 진단하는데, 공간과 인력적인 제한을 고려하였을 때 보통 근력은 악력으로 평가하고 근기능은 보행속도, 5-chair

stand test로 확인한다. 근육량은 DEXA와 BIA 두가지 방법으로 측정을 할 수 있다. 근육량이 감소해 있으면서 근기능 또는 근력중 한가지가 감소되어 있으면 근감소증(sarcopenia)로 진단하고 근육량, 근기능, 근력 세가지 모두 감소되어 있으면 심한 근감소증(severe sarcopenia)로 진단한다.

외래에서 근감소증으로 진단되는 경우 다른 질병에 의해서 근감소증이 발생하지는 않았는지 확인한다. 그 예로는 갑상선 기능 항진증, 당뇨, 신부전, 심부전, 만성 폐질환, 암 등이 있다. 이후에는 1차 근감소증에 대한 상세한 평가를 위해 노인 포괄평가를 시행하여 칼로리 섭취 부족 여부, 단백 섭취량 등을 파악한다. 근감소증에 대한 대부분의 중재는 운동과 영양 교육으로 이루어 지며, 적극적인, 전문적인 운동 치료와 교육 위해 재활의학과와 협진 하기도 한다. 아쉽게도 아직 약물로 근감소증을 치료할 수는 없어 지속적인 약물 개발과 표준화된 치료 전략의 설정이 필요하다.

15th Congress of The Korean Society of Sarcopenia

2023년 대한근감소증학회 제15차 학술대회

대학회장

Session III

Presidential Lecture

좌장: 장학철(서울의대)

Curriculum Vitae

원장원

소속: 경희의대

| 학력사항 |

서울대학교 의과대학 졸업
서울대학교 보건대학원 석사(보건학)
고려대학교 의과대학원 박사(예방의학)

| 경력사항 |

현) 경희의대 가정의학교실 주임교수
현) 경희대학교병원 어르신진료센터 센터장
현) 대한근감소증학회 회장
전) 대한노인병학회 이사장
전) 미국 University of Washington 노년내과 방문 교수(2003 – 2004)

근감소증 진단 기준 현황과 전망

경희의대
원장원

근감소증의 대표적인 진단 기준으로 revised European guideline과 2019 아시안 가이드라인(AWGS)가 있다. 전자는 근력감소가 있으면서 근육 량이나 근육의 질이 감소한 경우를 근감소증으로 정의학과 신체활동능력도 감소한 경우 중증 근감소증으로 정의하고 있다. 유럽지침에서 근육의 질 지표로 제안한 것은 근육조직검사나 CT, MRI 혹은 MRS로 근육내 지방 침착 정도를 평가, BIA로 phase angle 측정, 초음파로 echo-density 측정, 그리고 근력과 사지근육량의 비(ratio)이다.

2019 아시안 가이드라인은 근육량 감소와 더불어 근력이나 신체활동능력이 하나라도 감소한 경우를 근감소증이라 정의하고 있다. 두 지침 모두 근육량 측정을 위해서 DXA, BIA를 현재 추천하고 있다.

그런데 유럽의 지침에서도 보듯이 근육량 보다는 근력이 예후 예측에 더욱 정확하다는 연구결과들이 있다. 급기야 미국노인병학회 SDOC (Position Statements of the Sarcopenia Definition and Outcomes Consortium) 지침에서는 DXA로 근육량 측정하는 것을 추천하고 있지 않으며 근감소증의 정의는 근력감소와 보행속도 감소가 있을 때로 정의하자고 제안한 바 있다.

명심할 것은 근육량 측정 자체가 문제라기 보다는 현재의 DXA, BIA가 근육량을 직접 측정하는 방식이 아닌 데서 오는 오차 때문일 수 있다. 실제 5년 사망률을 조사한 Health ABC 연구에서도 근력 저하가 사망률 증가와 관련이 있고 DXA로 측정한 하지 근육량은 사망률과 관련이 없었지만, CT로 측정한 하지 근육표면적은 5년후 사망률과 유의한 관계가 있었다. 한편, 한 메타분석 연구에서는 일상생활기능 악화에 영향을 미치는 요인으로 악력, SPPB, 보행속도와 더불어 DXA나 BIA로 측정한 근육량 저하도 중요한 위험요인이었다. 즉 결과변수에 따라서는 DXA나 BIA로 측정한 근육량도 중요한 변수로 남을 수 있음을 시사한다. 최근 D3 Creatine dilution 기법으로 체내 근육량을 아주 정확하게 측정하는 기술이 제시되었고 예후 예측에도 좋다는 결과들

이 나오고 있다. 다만 D3 Creatine dilution 기법으로 측정한 체내 근육량은 얼굴과 몸통의 근육도 포함된 단점이 존재한다.

산재해 있는 전세계 근감소증 지침을 하나로 통일하고자 Global Leadership Initiative Sarcopenia (GLIS) 지침 개발이 진행되고 있으며 내년 초에는 그 지침이 개발될 것으로 보인다. 또한 아시아 근감소증 지침도 내년에 새로운 지침을 개발하기 위해 준비를 시작했다. 근육량 측정이 근감소증 진단기준에 잔존해 있을지는 지켜보아야 겠지만 분명한 것은 근력의 중요성에 대해 더욱 강조가 있을 것이며, 이와 관련해 근육의 질 평가의 중요성도 부각될 것으로 예상된다.

15th Congress of The Korean Society of Sarcopenia

2023년 대한근감소증학회 제15차 학술대회

대학회장

Session IV

근감소증 국내 역학연구 활성화; 국민건강영양조사 자료 활용

좌장: 이윤환(아주의대), 하용찬(서울부민병원)

Curriculum Vitae

김미지

소속: 경희대학교

| 학력사항 |

2007 M.S. University of Tsukuba, Japan
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2010 Ph.D. University of Tsukuba, Japan
Graduate School of Comprehensive Human Sciences

| 경력사항 |

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2016 – 2020 Assistant Professor
Department of Biomedical Science and Technology / East-West Medical Research Institute, Kyung Hee University
2014 – 2016 Senior Researcher
Research Team for Promoting Independence of the Elderly, Tokyo Metropolitan Institute of Gerontology, Japan
2013 – 2013 Visiting Scientist
Center on Aging and Health (Frailty Working Group)
Johns Hopkins University, USA
2011 – 2014 Researcher
Research Team for Promoting Independence of the Elderly, Tokyo Metropolitan Institute of Gerontology, Japan
2010 – 2011 Post-doctoral Fellow
Research Team for Social Participation and Community Health, Tokyo Metropolitan Institute of Gerontology, Japan

The Korean Frailty and Aging Cohort Study (KFACS)

경희대학교
김미지

A research project of the Construction of Frailty Cohort for Elderly and Intervention Study funded by the Ministry of Health and Welfare has been since December 2015 (grant number: HI15C3153, principal investigator: Chang Won Won). The main goal of this research project is as follows: to develop and track a cohort survey of frailty; to develop outcome prediction models (disability, hospitalization, mortality, etc.) for frailty; to develop an integrative intervention method and effectiveness verification for frail older people; and to establish standard guidelines for the prevention and management of frailty.

The Korean Frailty and Aging Cohort Study (KFACS) is a nationwide cohort study that began in 2016 with the aims of identifying and preventing the factors that contribute to aging in community-dwelling individuals aged 70 years or older. KFACS is a multicenter longitudinal study, and the baseline survey was conducted in 2016–2017. Sex- and age-stratified community residents aged 70–84 years, drawn from 10 medical centers urban and rural regions nationwide, were eligible for participation in the study. Of the 3014 participants, 1559 (51.7%) joined the study in 2016 and 1455 (48.3%) joined in 2017. The mean age was 76.0 years, and 1582 participants (52.5%) were female. In the baseline survey, face-to-face interviews, health examinations, and laboratory tests are performed at the clinical site of the study center.

The follow-up is conducted every 2 years through a clinic visit, home visit, telephone interview, and proxy interview. The KFACS follow-up survey (2021-2023) was funded by The National Institute of Health and the Korea Disease Control and Prevention Agency (2021-ER0605-00, principal investigator: Miji Kim). As of now, the six-year follow-up has been completed.

The KFACS questionnaire core includes sections directed at demographic, socioeconomic indicators, health status (comorbidity, polypharmacy, general healthcare and long-term care utilization, activities of daily living, instrumental activities of daily living, health literacy, health-related quality of life, depressive symptoms, sleep, appetite, resilience, functional constipation, and falls), lifestyle and health-related behaviors (smoking, alcohol consumption, physical activity, nutritional assessment, dietary patterns, and food security), social functioning (social networks, social capital, and social support), cognitive function tests using the Korean Version of the Consortium to Establish a Registry for Alzheimer's Disease Assessment Packet and Seoul neuropsychological screening Battery (global cognitive function, processing speed, memory, attention, and executive function. The KFACS clinic examination included a core of measurements of anthropometry (body weight, height, leg length, head circumference, waist circumference, upper arm, and calf circumference), vital signs, vision and hearing assessment, blood and urine testing, electrocardiography, chest X-ray, and physical performance tests (hand-grip strength, gait speed, short physical performance battery, and timed up and go test). In addition, the rich datasets included the dual energy X-ray absorptiometry (whole- and regional-body composition analysis). In addition, we stored frozen blood and urine samples for future measurements of biomarkers.

Comprehensive information can be accessed on the KFACS website (www.kfacs.kr). At the end of this presentation, until now, the published research findings on sarcopenia from the KFACS will also be introduced.

MEMO

Curriculum Vitae

이경호

소속: 국립보건연구원

| 학력사항 |

2001 서울대학교 보건대학원 석사(환경보건학과, 산업보건)
2007 서울대학교 대학원 의학과 박사(분자/환경/산업역학)

| 경력사항 |

2021 – 현재 질병관리청, 국립보건연구원 과장(4급)
2011 – 2021 삼성전자 건강연구소 부장
2010 – 2011 Post-Doc, 한국과학기술연구원(KIST) 융합오믹스센터
2001 – 2010 선임연구원, 서울대학교 의학연구원 환경의학연구소

한국인유전체역학조사사업(KoGES) 소개 및 연구 자원 활용

국립보건연구원
이경호

한국인유전체역학조사사업(KoGES)은 2001년부터 수행한 대규모 코호트 사업으로써 만성질환 예방 및 관리 정책의 과학적 근거를 마련하기 위해 질환의 유전·환경 요인 및 상호작용 규명을 목적으로 하고 있다. 건강 및 생활습관 설문조사 및 검진으로 23만 5천명의 대규모 코호트를 구축하여 기반조사를 완료하였으며 현재는 추적조사를 통해 역학자료 및 인체유래물을 수집하고 있다. 또한 일반인구집단에서 노쇠의 원인 규명 및 예측인자 연구를 위한 정보 수집과 고려인구 연구의 인프라 구축 및 예방 기술 개발을 위한 노인노쇠코호트 구축 및 추적조사 사업을 진행 중에 있다.

수집한 자료는 코호트 역학정보의 고부가가치를 창출하기 위해, 기 수집된 자원을 활용하여 임상역학정보는 추가로 생산하기도 하고 타공공기관 자료를 연계 등을 통하여 역학 자료의 생산을 확대 추진하고 있다. 현재 수집된 KoGES 자료는 연구자를 위해 정제 및 분양을 지속적으로 이루어지고 있다. 또한 자료 활용에 대한 가이드북 제공 및 워크숍 등을 통해 연구자들이 자료 이용을 원활이 이루어질 수 있는 방법을 제공하고 있다.

KoGES 자료를 활용한 연구를 위해서는 KoGES 분양 자료의 구성 및 조사 항목에 대한 사전 확인이 중요하다. 연구자는 질병관리청 홈페이지에 게시된 KoGES 조사항목, 설문 구조, 코드북 등을 확인하여 연구자가 수립한 연구가설의 검증이 KoGES 자료 안에서 가능할지를 미리 판단해볼 수 있다. 또한 함께 게시되어 있는 자료 분석 가이드북과 교육용 데이터를 이용하여 간단한 예비 분석도 직접 수행해 볼 수 있다.

또한, 대규모 연구 자료의 활용성을 향상시키기 위해 생성한 두 가지의 통합자료(KoGES 기반조사 통합자료, KoGES 추적조사 통합자료)를 분양하고 있다. KoGES 기반조사 통합자료는 지역사회기반, 도시기반, 농촌기반 코호트 기반조사 자료의 공통 조사 항목을 중심으로 통합한 자료이고, KoGES 추적조사 통합자료는 지역사회기반 코호트 기반자료와 추적자료를 통합한 것이다. 자료의 통합을 위해 자료 질 관리 위원회를 구성하

여 통합 대상 변수를 선정하고 수집 과정을 검토하였으며, 조사 단위 별 자료 분포 비교 및 내·외부 자문을 통해 통합 지침을 개발하고 통합 자료를 생성하였다.

KoGES 자료의 공개는 자료 정제를 마친 후 이루어지며, 미공개 자료도 단계적으로 추가 정제 및 공개되고 있다. 지역사회기반 코호트 10차 추적 조사 자료에 대해서 차수 당 약 500~1000개의 변수를 추가로 공개하였다. 추가로 공개된 변수에는 수면력, 관절염, 질병력, 폐기능, 우울증, 치매, 인지 평가 등의 역학 자료와 Adiponectin, Apolipoprotein (A1, B), C-peptide, Vitamin B12, 25-(OH) Vitamin D 등의 추가 혈액 분석 결과 자료가 포함되어 있다. 연구자들은 KoGES 자료 분양 절차를 통해 이 자료들을 연구 목적으로 이용할 수 있다.

지금까지 KoGES를 자료를 활용한 연구 논문은 약 1,500편 이상 게재되었으며, 향후 대기오염자료와 연계된 환경 및 생활습관에 의한 건강영향 자료와 고령인구 및 여성 건강에 대한 자료도 추가 공개 예정이다.

MEMO

Curriculum Vitae

오경원

소속: 질병관리청 건강영양조사분석과

| 학력사항 |

1990 – 1994 연세대학교 식품영양학과 박사

| 경력사항 |

2020 – 현재 질병관리청, 건강영양조사분석과 과장
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2002 – 2004 Harvard School of Public Health Research Fellow
2001 – 2002 연세대학교 Brain Korea(BK) 21 연구교수
1996 – 1999 연세대학교 보건대학원 연구강사

국민건강영양조사 근감소증조사 소개

질병관리청 건강영양조사분석과
오경원

국민건강영양조사는 국민건강증진법에 근거하여 1998년부터 매년 약 10,000명을 대상으로 설문, 계측, 검체분석 등의 방법으로 국민의 건강행태, 영양, 만성질환 현황을 파악하여 건강정책 수립 및 평가의 근거자료를 생산하고 있다. 수집된 자료는 복합표본설계임을 고려하여 우리 국민의 특성을 대표할 수 있도록 가중치(표본추출률, 응답률, 해당연도 모집단 인구구성비 반영)를 적용하여 건강행태, 영양소 섭취, 만성질환 유병 및 관리지표를 산출하며, 국가건강조사 분과 및 조정자문위원회 검토 후 결과발표회, 보도자료, 통계집「국민건강통계」등을 통해 결과를 발표하고 있다. 조사 원시자료는 연구자가 학술적으로 활용하도록 조사완료 1년 후에 국민건강영양조사 홈페이지(http://knhanes.kdca.go.kr)를 통해 자료이용지침서, 조사 질관리 보고서와 함께 공개하고 있다.

노인 인구비율이 증가함에 따라 근육량, 골밀도 감소로 인한 근감소증, 골다공증 예방 및 관리의 중요성이 더욱 강조되고 있다. 국민건강영양조사에서도 이를 고려하여 2008년-2011년 조사에 이중에너지방사선흡수법(dual energy X-ray absorptiometry, DXA)를 도입하여 근육량, 골밀도를 측정하였고, 2019년 악력 측정자료를 토대로 Asian Working Group for Sarcopenia (AWGS, 2019) 기준을 적용한 악력저하율을 산출하였다. 또한, 근감소증 유병률을 산출하기 위해 2022년 조사에 생체전기저항측정법(bioelectrical impedance analysis, BIA)을 도입하였고, 보다 정확한 근감소증 유병 추이 및 관련 연구 기반을 제공하기 위해 2024년-2028년 조사에 DXA를 재 도입할 예정이다. 전담조사원에 의한 측정, 주기적 측정 장비 질관리, 전문가가 참여한 현장 질관리(지침 준수여부 등 평가) 등을 통해 자료의 정확성을 확보하고, 신체활동, 영양, 만성질환 유병 여부 등 근감소증 관련 위험요인을 상세하게 조사할 계획이다. 이를 통해 근감소증 예방 및 관리에 필요한 근거를 지속적으로 생산하고 관련 분야의 다양한 분석 연구를 지원하기 위해 원시자료를 공개하고자 한다.

또한, 국민건강영양조사의 단면조사 특성으로 인해 근감소증 관련요인을 인과관계로 해석하기 어려운 제한점을 보완하기 위해 국민건강영양조사 자료를 통계청(사망원인통계), 환경부(대기오염노출 자료) 등 타 기관 자료와 연계·대국민 공개 중에 있으며 이를 단계적으로 확대할 계획이다.

MEMO

Curriculum Vitae

안성희

소속: 인하의대

| 학력사항 |

2005 – 2009 이화여자대학교 의과대학 학사
2012 – 2014 울산대학교 석사(내과학)
2014 – 2016 울산대학교 박사(내과학)

| 경력사항 |

2023 – 현재 인하대병원 내분비내과 부교수
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2016 – 2017 인하대병원 내분비내과 임상강사
2014 – 2015 서울아산병원 내분비내과 전임의
2010 – 2013 서울아산병원 내과 전공의
2009 – 2010 서울아산병원 수련의

국민건강영양조사 근감소증 관련 연구

인하의대
안성희

국민건강영양조사(Korean National Health & Nutrition Examination Survey, KNHAES)는 매년 우리나라 국민 1만명에 대한 건강수준, 건강관련 의식 및 행태, 식품 및 영양 섭취 실태 조사를 통해 국가 단위 통계를 산출하는 전국 규모의 조사이다. 국민건강영양조사의 결과는 국민의 건강수준 평가를 통해 새로운 건강 정책을 개발하거나 보완하는데 사용될 뿐 아니라 건강 증진과 질병 예방을 위한 다양한 연구에도 활용되고 있다. 특히, 국민건강영양조사의 검진 조사 항목에는 신체 계측, 혈압 측정, 질환과 연관된 혈액 검사(이상지질혈증, 당뇨병, 신장기능, 간기능 및 간염, 빈혈, 일반 검사 등), 소변 검사 등이 포함되어 있어 다양한 만성 질환과 관련된 위험 인자, 질환과 질환 사이의 연관성 연구 등이 국민건강영양조사 자료를 통해 무수하게 발표되었다. 또한 국민건강영양조사에서는 시기별로 특수한 검진 조사 항목을 추가하여 시행하였는데, 특히, 제4-5기에는 (2008-2011년) DEXA 장비를 이용하여 골밀도 검사 및 전신 체성분 검사가 시행 되었고, 제6기부터(2014년-) 현재까지 악력 측정이 시행되고 있다.

근감소증은 노화로 인해 근육량이 감소하면서 근육의 강도가 감소하고 신체기능이 저하되는 상태로 정의된다. 근감소증은 노인에서 노쇠, 낙상 및 골절을 유발하고 이는 사망의 증가로 까지 이어질 수 있어 고령화 사회에서 임상적 의미가 큰 질병 상태로 ICD-10CM에서는 근감소증을 질병으로 명명하고 있다. 따라서 고령화 사회에서 근감소증을 진단하고 적절하게 관리하는 것이 중요하다. 최근에 우리나라에서 개정된 권고안에서는 근육량, 근육 강도 및 신체기능의 조합을 통해 근감소증을 진단하도록 권고하고 있으며, 이때 근육량의 지표로 appendicular skeletal muscle mass (ASM), 근육 강도의 지표로 악력(handgrip strength, HGS) 및 신체기능의 지표로 gait speed, timed up and go, chair stand test, 400-m walk test를 사용할 것을 권고하고 있다.

국민건강영양조사에서 시행되었던 전신 체성분 검사(근육량, 지방량 및 골량) 및 악력 검사는 근감소증의

진단 기준에 해당하는 지표들을 제공하기 때문에 이 조사 결과들이 발표된 이후부터 우리나라에서 국민건강영양조사 자료를 이용한 다양한 근감소증 연구들이 수행되었다. 이 연구들에서는 우리나라 국민들에서 근감소증과 관련된 근육량 또는 악력 지표들의 참고치를 발표하였고, 이 지표들과 다양한 질환들 또는 다양한 검진 항목, 영양조사 항목들과의 연관성을 분석하였다. 이번 세션에서는 이와 같이 우리나라 국민건강영양조사 자료를 활용한 근감소증 관련 연구들을 살펴보려고 한다.

대학회장

Session V

Session V

근감소증 중재 요법

좌장: **박세정**(한국스포츠정책과학원), **이해정**(가천대)

Curriculum Vitae

김일영

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| 학력사항 |

1999	Physical Education at Dong-A University, Busan, South Korea
2004	Graduate Program in the Department of Integrative Biology Exercise Physiology, University fo California at Berkeley
2004 – 2007	M.A. in Eercise Physiology, Department of Kinesiology University of Texas at Austin

| 경력사항 |

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2015 – 2017	Assistant Professo r(Tenure tract) – Clinical metabolism Center for Translational Research in Aging&Longevity, Geriatrics, University of Arkansas for Medical Sciences, Little Rock, AR
2013 – 2015	Faculty Instructor – Clinical metabolism Center for Translational Research in Aging&Longevity, Geriatrics, University of Arkansas for Medical Sciences, Little Rock, AR
2012 – 2012	Post-doctoral fellow – Clinical metabolism Center for Translational Research in Aging&Longevity, Geriatrics, University of Arkansas for Medical Sciences, Little Rock, AR

Dietary Essential Amino Acids Amplify Exercise-Mode Dependent Adaptations and Beyond: Therapeutic Implications for Aging Muscle

가천의대
김일영

Exercise is the most powerful natural muscle booster that induces beneficial physical (e.g., improved muscle strength and endurance) and metabolic adaptations (e.g., improved insulin sensitivity), with specific effects or adaptations of exercise training differing depending on the specific mode of exercise: resistance exercise training (RET) for muscle mass and strength and endurance exercise training (EET) for endurance. While achieving both aspects of adaptations being ideal, simultaneous application of both modes of exercise training (i.e., RET+EET) may counteract adaptive responses mutually, called "interference effects". Balanced essential amino acids (EAAs) is an "ideal" option that bypasses the interference effects by serving not only as potent anabolic signals for protein translation but as building blocks for making new proteins (both contractile and mitochondrial proteins). We hypothesized that supplementation of balanced free 9 essential amino acids (EAA) to RET or EET improves both aspects of exercise training adaptations with associated improvements of metabolic health. Here I will discuss general overview on beneficial physical and metabolic effects of each mode of exercise training, and then (2) beneficial effects of addition of free balanced EAA supplementation to RET or EET that can simultaneously enhance both muscle strength and quality and endurance capacity with improved metabolism in muscle and other tissues in several normal and patho-physiological models of aging, obesity, and so on. To explore these at physiological, metabolic, and molecular aspects in several mouse models, we employed both metabolic kinetics or "dynamics" approach using various stable isotope tracing techniques in conjunction with mass spectrometry to access cumulative synthesis rates of muscle

proteome (“proteome kinetics) using heavy water labeling method, systemic and intracellular turnover fluxes of various metabolites including glucose, amino acids, and fatty acids, TCA cycle fluxes as well as whole-body and muscle insulin sensitivity using hyperinsulinemic-euglycemic clamp and traditional “statomics” (static, snapshot) techniques such as RNA-seq to access ex vivo contractile properties, in vitro mitochondrial function, neuromuscular junction stability, and molecular singling.

Keywords: Metabolic dysregulation, muscle mass, muscle function, physical performance, muscle protein synthesis rate, in vivo metabolite flux, stable isotope tracer methodology.

MEMO

Curriculum Vitae

이세원

소속: 인천대학교 체육학부

| 학력사항 |

1995 – 1999 B.A. Seoul National University, Seoul, Republic of Korea (Physical Education)
1999 – 2001 M.A. Seoul National University, Seoul, Republic of Korea (Clinical Exercise Physiology)
2006 – 2007 Texas A&M University, College Station TX, USA

| 경력사항 |

2014 – Present Assistant/Associate Professor, Division of Sport Scinece Incheon National University
2012 – 2014 Post-Doctoral Fellow, Dalton Cardiovascular Research Center University of Missouri, Columbia, MO
2008 – 2011 Graduate Research Assistant, Department of Medical Pharmacology & Physiology
2009 – 2010 Teaching Assistant, MPP 3202 Elements of Physiology, Department of Medical Pharmacology & Physiology University of Missouri, Columbia, MO

근감소증 예방과 치료를 위한 운동중재: 마른 비만 대상자를 중심으로

인천대학교 체육학부

이세원

근감소증은 노화와 함께 가속되지만, 그 시작은 노화 시점 이전부터 진행될 수 있다. 마른 비만은 BMI가 정상범위에 해당하지만, 체지방률이 높고 상대적으로 더 적은 근육량의 특징을 가지고 있다. 선행연구들에 따르면, 마른 비만 집단은 체지방률이 비만에 해당하는 특징을 가지고 있어 중성지방 및 나쁜 콜레스테롤 수치가 높고 대사증후군 발병률이 증가할 수 있다.

특히 마른 비만자의 경우 외형상 비만으로 보이지 않아 질환의 위험성을 인식하지 못한다는 점에서 그 위험성이 더욱 심각하다. 마른 비만은 남성보다 여성에게서 더 두드러지게 나타나고 폐경 이후에는 그 대사 및 심혈관계 질환 발병 위험성이 증가할 수 있다. 따라서 근감소증 예방과 치료를 위한 적절한 운동 중재가 마른 비만자의 향후 질환으로의 전이를 사전에 차단 할 수 있는 선제적 예방 전략이 될 수 있다. 본 강의에서는 마른 비만의 대사 및 심혈관계 질환의 위험성을 살펴보고, 이를 극복할 수 있는 효과적인 저항성 운동 중재의 효과를 마이오카인 측면에서 고찰하고자 한다.

Curriculum Vitae

유명철

소속: 경희의대

| 학력사항 |

경희대학교 의학전문대학원 의무석사
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| 경력사항 |

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경희대병원 재활의학과 임상조교수
경희대병원 재활의학과 전임의
강동경희대병원 재활의학과 전공의

근감소증 환자에서의 재활 중재

경희의대
유명철

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- Introduction
  - Anatomical and cellular, molecular changes in sarcopenia
  - Prevalence of sarcopenia
- Exercise intervention in sarcopenia
  - Clinical practice guidelines
  - Effective resistant exercise prescription and delivery
  - Effects of other types of exercise
- Comprehensive geriatric assessment
  - Importance of indivisualized approach

경희의료원 강동경희대학교병원

Introduction

경희의료원 강동경희대학교병원

Anatomical and cellular, molecular changes in sarcopenia

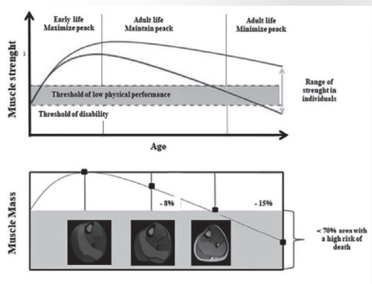
Anatomical changes	Cellular and molecular changes
Neurodegeneration	Anabolic resistance
Muscle atrophy	Altered proteostasis
Myosteatosis	Low-grade inflammation
Reduction in type II muscle fibres	Mitochondrial dysfunction (oxidative stress)
	Hormonal changes
	Altered satellite cell number/ function

Edwards et al., Physical and OT in geriatics (2023).

경희의료원 강동경희대학교병원

Anatomical and cellular, molecular changes in sarcopenia

- **Changes in muscle strength and muscle mass along lifespan**

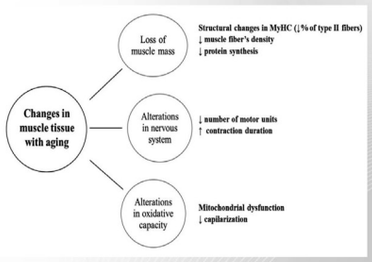


Arc-Chagnaud et al., Sports Medicine and Health Science (2019).

경희의료원 강동경희대학교병원

Anatomical and cellular, molecular changes in sarcopenia

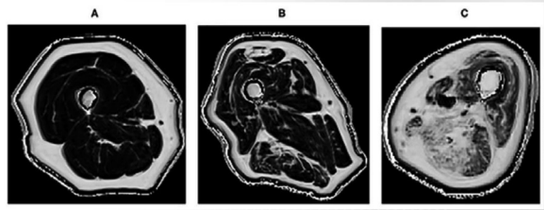
- Main changes in muscle tissue with aging



Arc-Chagnaud et al., Sports Medicine and Health Science (2019).

Anatomical and cellular, molecular changes in sarcopenia

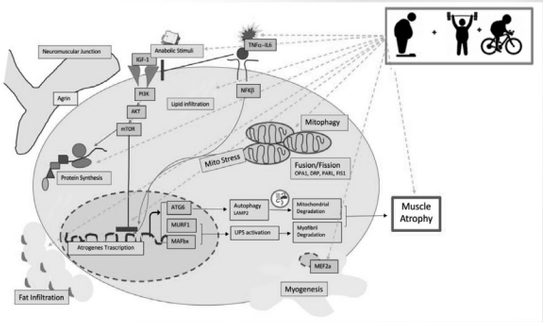
- **Myostasis** : process of increased uptake of lipids into the muscle adipocytes



Farrow et al., Frontiers in Medicine (2020).

Anatomical and cellular, molecular changes in sarcopenia

- Common etiologies of sarcopenia



Colleluori et al., Experimental Gerontology 155 (2021).

Prevalence of sarcopenia

1. Community-dwelling elderlies

Definition	Data from Carvalho do Nascimento PR [13]			Data from Petermans-Rocha F [14]		
	No. of studies	N	Prevalence (%)	No. of studies	N	Prevalence (%)
EWGSOP	31	36,811	11 (7-14)	48	200,590	22 (20-25)
EWGSOP2	4	6624	5 (1-10)	3	5720	10 (2-17)
AWGS	13	17,070	8 (3-15)	46	27,940	15 (13-17)
IWGS	5	6993	17 (11-23)	12	11,890	14 (9-18)
FNIH	5	13,338	15 (5-28)	20	27,864	11 (9-14)
All above	58	80,836	10 (7-12)	129	274,004	16 (15-17)

AWGS, Asian Working Group for Sarcopenia; EWGSOP, European Working Group on Sarcopenia in Older People; EWGSOP2, European Working Group on Sarcopenia in Older People 2; FNIH, Foundation for the National Institute of Health; IWGS, International Working Group on Sarcopenia.

- EWGSOP - defined sarcopenia : 7- 25%
- EWGSOP2- defined sarcopenia : 1-17%
- AWGS - defined sarcopenia : 3-17%

Yuan et al., Metabolism (2023).

Prevalence of sarcopenia

2. Different medical situation elderlies

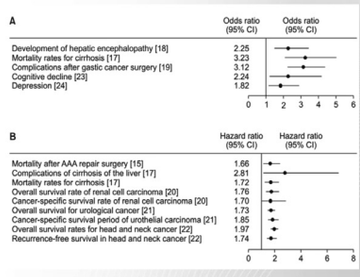
PMID	First author	Population	Studies	N	Prevalence
34399402	Meyer HJ	Patients in critically ill	9	1563	26.3-71.1 %
30389220	Hajibandeh S	Patients with abdominal surgery	20	5324	12.0-56.6 %
28386715	Jones K	Patients with abdominal surgery	24	5267	15-65 %
34078275	Zhang XM	Patients with an intensive care	14	3249	41 %
32131764	Zhang XM	Patients with breast cancer	6	5497	15.9-66.9 %
34337889	Takenaka Y	Patients with cancer receiving immune checkpoint inhibitors	36	3501	21.9-75.0 %
34785325	Tantai X	Patients with cirrhosis	22	6965	37.50 %
34406490	Xie H	Patients with colorectal cancer	19	15,889	12.0-68.2 %
33481108	Trejo-Avila M	Patients with colorectal cancer	44	18,891	37 %
34958651	Feng L	Patients with diabetes	45	12,237	18 %
36233729	Wathanavasin W	Patients with dialysis	41	7576	25.60 %
34989172	Shu X	Patients with dialysis	30	6162	4-68 %
35284466	Xu XT	Patients with diffuse large B-cell lymphoma	12	2324	23.9-55.6 %
30955115	Hua H	Patients with digestive carcinoma surgery	11	2419	11.6-33.0 %
35347023	Ng JQ	Patients with emergency laparotomy	12	2461	29.50 %
35379520	Park B	Patients with emergency laparotomy	12	6737	34.50 %
35288290	Dakis K	Patients with endovascular aortic aneurysm repair	11	2385	40.30 %
35077542	Chen F	Patients with esophageal cancer	26	4515	14.4-80 %
32193528	Papaconstantinou D	Patients with esophageal cancer	11	1979	14.4-83 %
24249675	Jin SB	Patients with esophageal cancer	11	1485	15.8-60.7 %
29846548	Bushier PR	Patients with esophageal cancer	18	3193	16-75 %
32040700	Wang PY	Patients with esophagectomy	14	2387	36.1-55.3 %
34496449	Li YX	Patients with female cancer	23	3495	46.90 %
29987739	Yang Z	Patients with gastric cancer	13	4262	6.8-57.7 %
34601314	Chen F	Patients with gastric cancer resection	20	7615	6.8-44.8 %
31796090	Su H	Patients with gastrointestinal cancer	70	21,875	2.1-83.3 %
35739153	Wang H	Patients with gastrointestinal oncological surgery	43	16,716	32.3 %
32822372	Pipek LZ	Patients with gastrointestinal surgery	11	4265	6.8-35.9 %
32134194	Sutton EH	Patients with gynecological cancer	27	4586	11-59.2 %
32117787	Hua X	Patients with head and neck cancer	11	2483	6.6-64.6 %
32994071	Findlay M	Patients with head and neck cancer and radiotherapy	7	1059	6.8-64.6 %
32090284	Jin S	Patients with hematopoietic stem cell transplantation	7	1752	35.5-49.0 %
35876662	Edwards A	Patients with papillomavirus-positive oropharyngeal cancer	9	744	42.90 %
36403578	Zhang JZ	Patients with kidney transplantation	23	2535	26 %
29065187	Kim G	Patients with liver cirrhosis	20	4037	25-70 %
35671958	Wu WT	Patients with lumbar degenerative spine disease	14	1953	24.80 %
31128115	Yang M	Patients with lung cancer (NSCLC)	13	1810	43 %
31128115	Yang M	Patients with lung cancer (SCLC)	13	1810	52 %
32768316	Surov A	Patients with malignant hematological diseases	7	1578	24.6-66.1 %
35578299	Jiang T	Patients with mechanical ventilation	17	3582	43.00 %
35817900	Surov A	Patients with melanoma receiving immunotherapy	6	719	40.20 %
30348603	Deng HY	Patients with non-small cell lung cancer	6	1213	14.0-55.8 %
30266663	Mintziras I	Patients with pancreatic cancer	11	2297	45.40 %
34714076	Takenaka Y	Patients with patients with head and neck cancer	18	3233	13.9-74.7 %

Yuan et al., Metabolism (2023).

Prevalence of sarcopenia

3. Mortailty with different medical conditions

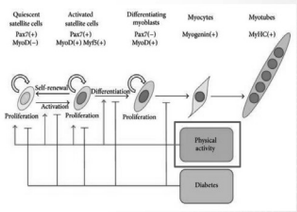
: increased mortality and complication rates of various diseases

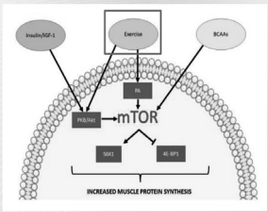


Kakehi et al., Rehabilitation Nutrition (2020).

Anatomical and cellular, molecular changes in sarcopenia

- **Purpose of exercise intervention**
  - Improve muscle quality
  - Increase the number of mSCs (Improved muscle regeneration)





Fujimaki et al., BioMed Research International (2015).

Exercise intervention in sarcopenia patients

Exercise intervention for eldery

- **Participants**
  - 1635 patients (70-89 yrs)
  - SPPB<9,
  - able to walk 400m
  - f/u 2.6 years

Research

Original Investigation

Effect of Structured Physical Activity on Prevention of Major Mobility Disability in Older Adults
The LIFE Study Randomized Clinical Trial

Marco Pahor, MD; Jack M. Guralnik, MD, PhD; Walter T. Ambrosius, PhD; Steven Blair, PED; Denise E. Bonds, MD; Timothy S. Church, MD, PhD, MPH; Mark A. Espeland, PhD; Roger A. Fielding, PhD; Thomas M. Gill, MD; Erik J. Groessl, PhD; Abby C. King, PhD; Stephen B. Kritchevsky, PhD; Todd M. Manini, PhD; Mary M. McDermott, MD; Michael E. Miller, PhD; Anne B. Newman, MD, MPH; W. Jack Rejeski, PhD; Kaycee M. Sink, MD, MAS; Jeff D. Williamson, MD, MHS; for the LIFE study investigators

- **Interventions**
  - structured, moderate-intensity physical activity program (n = 818)
  - health education program (n = 817)

Pahor et al., JAMA network. (2014).

Clinical practice guidelines for older people with sarcopenia

- **Singapore CPG**

ACHIEVING MUSCLE AND METABOLIC HEALTH
https://doi.org/10.33591/sfp.49.3.u1

Unit No. 1

SINGAPORE CLINICAL PRACTICE GUIDELINES FOR SARCOPENIA: SCREENING, DIAGNOSIS, MANAGEMENT, AND PREVENTION

A/Prof Lim Wee Shiong

C. Treatment	1. Older persons with sarcopenia should be encouraged to participate in resistance-based exercises to improve muscle strength and physical performance.	Strong
	2. Clinicians should advise older persons with sarcopenia on the importance of a quality diet with adequate caloric and protein intake.	Conditional
	3. Clinicians should consider nutritional intervention with protein supplementation for older persons with sarcopenia.	Conditional
	4. Nutritional intervention should be combined with physical exercise to improve muscle strength and physical performance in older persons with sarcopenia.	Conditional
	5. We do not recommend prescription of pharmacotherapy for the specific management of sarcopenia in older adults.	Conditional

Lim SW, ACHIEVING MUSCLE AND METABOLIC HEALTH (2023).

Clinical practice guidelines for older people with sarcopenia

- **Australia and New Zealand CPG**

Consensus guidelines for sarcopenia prevention, diagnosis and management in Australia and New Zealand

Number	Statement	Agreement (%)
Management		
12	Accredited healthcare professionals (or degreed, NZ) should provide an accessible explanation of sarcopenia, including provision of informative material, to those diagnosed with sarcopenia to support engagement in self-determined health behaviours.	89.6
13	All persons with sarcopenia should be offered resistance-based training by an accredited healthcare professional (or degreed, NZ), tailored to the individuals' abilities and preferences.	92.5
14	Optimization of energy and protein intake is likely to be beneficial for all persons with sarcopenia, but benefits may be greatest when combined with a physical activity intervention, such as resistance exercise.	97.9
15	Clinicians should consider referring persons with sarcopenia to a dietitian for the development of a dietary and protein optimization plan.	90.9
16	Total protein intake of 1–1.5 g/kg/day should be considered for older adults with sarcopenia, excepting those with significant kidney disease defined by an eGFR of <30 mL/min/1.73 m^2.	86.7

Zanker et al., J Cachexia, Sarcopenia and Muscle. (2023).

Clinical practice guidelines for older people with sarcopenia

- **Canada CPG**

1213
NRC Research Press
REVIEW

Are Canadian protein and physical activity guidelines optimal for sarcopenia prevention in older adults?

Camila L.P. Oliveira, Isabelle J. Dionne, and Carla M. Prado

Table 2. Key opportunities for improving *Canadian Physical Activity Guidelines for Older Adults*.

Canadian Physical Activity Guidelines for Older Adults should be better disseminated
Guidelines for older adults should emphasize the importance of RET and how it should be implemented
Guidelines should provide detailed information on which RET should be performed, how often, how much, and how to progress as a strategy to increase involvement and adherence
Information on the context in which physical activity should occur should be added to the guidelines as it may increase participation rates and would help older adults explore new individualized strategies

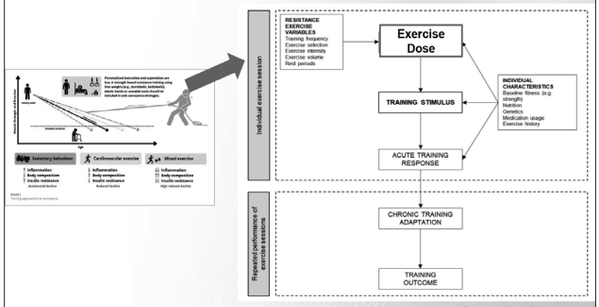
Note: RET, resistance exercise training.

Oliveira et al., Appl. Physiol. Nutr. Metab. (2018).

Effective resistant exercise prescription and delivery

- **How? Resistant exercise variables**

  : exercise selection, intensity, volume, frequency, resting period (Exercise Dose)



Hurst et al., Age and Ageing. (2022).

Effective resistant exercise prescription and delivery

- **Proposed Ex prescription for older adults with sarcopenia**

Variables		
Traning frequency	Two sessions per week	
Exercise selection	Lower body Squat Leg press Knee extension Leg curl Calf raise	Upper body Chest press Seated row Pull down Dips
Exercise intensity	40–60% 1RM → 70–85% 1RM	RPE 3–5 → RPE 6–8
Exercise volume	1–3 sets of 6–12 repetitions	
Rest periods	60–120 s between sets 3–5 min between exercises	

Hurst et al., Age and Ageing. (2022).

Effects of other types of exercise?

- **Resistive exercise training (RET)**
- **Aerobic exercise training (AET)**
- **Balance training**
- **Flexibility training**

BMC Geriatrics

RESEARCH Open Access

Effects of different exercise training modes on muscle strength and physical performance in older people with sarcopenia: a systematic review and meta-analysis

Lu et al. BMC Geriatrics (2021) 21:708 https://doi.org/10.1186/s12877-021-02642-8

Linqian Lu[1,2†], Lin Mao[3†], Yuwei Feng[4†], Barbara E. Ainsworth[4], Yu Liu[1] and Nan Chen[1,2*]

1) RET, Mixed training (RET+AET)
: knee extension strength, TUG, gait speed

2) WBVT: only TUG

Lu et al., BMC Geriatrics. (2021)

Effects of other types of exercise?

Exercise for sarcopenia in older people: A systematic review and network meta-analysis

Yanjiao Shen[1,2,3], Qingyang Shi[4], Kaiwi Nong[5], Sheyu Li[6], Jirong Yue[3], Jin Huang[3], Birong Dong[3], Maria Beauchamp[7] & Ojukwu Rao[7,8]

Participants
- 3728 patients with 42 RCTs

- Resistant ex.
- Balance
- Aerobic
- Nutrition

Intervention		Quality of life	Muscle strength	Physical performance		
		Quality of life (scale, SMD, 95% CI)	Handgrip strength (MD, 95% CI)	Usual gait speed (MD, 95% CI)	Timed up and go (MD, 95% CI)	Chair stand test (MD, 95% CI)
Resistance	Resistance	1.31 (0.54 to 1.68)	2.69 (1.78 to 3.61)	0.11 (0.04 to 0.18)	-0.83 (-1.60 to 0.02)	-0.4 (-2.21 to 1.41)
	Resistance plus Nutrition	1.07 (0.23 to 1.91)	3.93 (2.22 to 5.64)	0.13 (0.01 to 0.25)	-0.77 (-2.16 to 0.63)	-0.75 (-2.38 to 1.07)
Resistance and Balance	Resistance and Balance	0.41 (-0.55 to 0.76)	1.23 (-0.16 to 2.62)	0.16 (0.08 to 0.24)	-1.05 (-3.22 to -0.49)	-1.79 (-2.97 to -0.6)
	Resistance and Balance plus Nutrition	0.36 (-0.24 to 0.95)	4.19 (2.55 to 5.83)	0.16 (0.06 to 0.26)	-1.24 (-3.33 to 0.25)	
Resistance and Aerobic	Resistance and Aerobic	-0.07 (-0.52 to 0.38)	1.94 (0.79 to 3.08)	0.1 (-0.01 to 0.22)		-1.72 (-3.17 to -0.27)
	Resistance and Aerobic plus Nutrition	0.12 (-0.34 to 0.59)	5.02 (3.64 to 6.4)	0.08 (-0.04 to 0.19)		-2.28 (-3.73 to -0.83)
Resistance and Aerobic and Balance	Resistance and Aerobic and Balance	0.68 (0.32 to 1.04)	0.2 (-1.3 to 1.9)	0.04 (-0.14 to 0.22)	-1.71 (-3.09 to 0.39)	
	Resistance and Aerobic and Balance plus Nutrition		1.1 (-0.14 to 2.71)			
Aerobic	Aerobic	0.39 (-0.06 to 1.22)	0.44 (-1.13 to 2.04)			
Balance	Balance		0.39 (-2.32 to 3.09)			

Shen et al., J Cachexia, Sarcopenia and Muscle (2023)

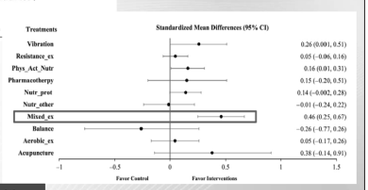
Effects of other types of exercise?

JAMDA

Review Article

Management of Sarcopenia: A Network Meta-Analysis of Randomized Controlled Trials

Ahmed M. Negm MD, MSc, PhD[1,2], Jeremy Lee MD[3], Radmehr Hamidian BSc[2], C. Allyson Jones PT, PhD[1], Rachel G. Khadaroo MD, PhD[3]



Mixed training (RET+AET) with nutritional supplementation are the most effective sarcopenia

Negm et al., JAMDA (2022)

Effects of other types of exercise?

- **Proposed Ex prescription for older adults with sarcopenia (1)**

	Frequency	Intensity	Duration (min)[a]	Type	Progression
Resistance exercise	1–5 session/week	20–80% of 1 Repetition Maximum (1-RM) or 6–14 points on Rating of Perceived Exertion (RPE) Volume of the exercise: 1–3 sets, 10–15 reps	20–75	Upper limb: biceps curl, triceps curls, double arm pull down, shoulder abduction/flexion, bench press, military press, seated row, bent row over Lower limb: knee flexion/extension, hip abduction/extension, leg press, squatting, calf raises, kick back, lunges Trunk: abdominal crunch and back extension	3 ways: 20–30% of 1RM progressing to 70–79% 1RM Body weight to thera band to ankle weights/sand bags to machine based Changing the volume of the exercise
Aerobic exercise	2–5 session/week	50–70% of HR_{max} or 7–17 point on RPE	6–30	Walking, slow running, fixed cycle ergometer, anterior/posterior/lateral repetitive stepping, stationary bicycle	3 ways: HR_{max} from 50 to 55% progressing to 65–70% RPE from 7 points progressing to 17 Varying the exercise duration keeping intensity constant/decreasing/increasing
Balance exercise	2/3 session/week	3 point on the scale of 10	5–30	Static balance: broad base standing, feet together, tandem stand, weight shifts, heel-up stand, one-leg stand Dynamic balance: heel raise, toe raise, heel/toe waling, vibration platform, stepping (anterior–posterior and lateral), quick directional change, complex cross over stepping activity, reaching	Increasing the difficulty level of exercise example from broad base to narrow base or from statics to dynamic
Stretching exercise	Static stretching exercise during warm-up and cool down				

Kumar et al., Eur Geriatr Med (2022).

Effects of other types of exercise?

- **Proposed Ex prescription for older adults with sarcopenia (2)**

Table 1
General recommendations on exercise-based interventions to treat age-associated sarcopenia and frailty.

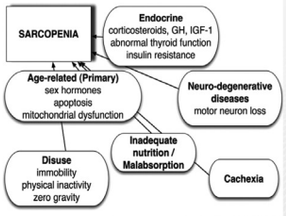
Exercise modality	Duration	Volume	Intensity	Frequency	Indication
RESISTANCE	Variable (10–60 min)	8–10 exercises involving major muscle groups.	Progressive (until 80% 1RM)	2–3 times/week (range 1–6)	SARCOPENIA (+++) FRAILTY (++)
	3 months (range 2–12 months)	Progressive (1–3 sets, 6–12 repetitions)			
ENDURANCE	20–60 min	Progressive	Progressive (moderate to high; 6–8 points on a RPE scale)	3–5 days/week	SARCOPENIA (++) FRAILTY (++)
	3 months (range 2–12 months)				
MULTICOMPONENT: RESISTANCE (R) + ENDURANCE (E) + BALANCE (B) + FLEXIBILITY (F)	45–60 min *Pre-frail:* 20 min R + 10 min E + 20 min B + 10 min F *Frail:* 10 min R + 20 min E + 8 min B + 7 min F	Progressive	Progressive (moderate to high; 6–8 points on a RPE scale)	2–3 times/week (range 1–7)	SARCOPENIA (+++) FRAILTY (+++)
	3 months (range 1–18 months)				

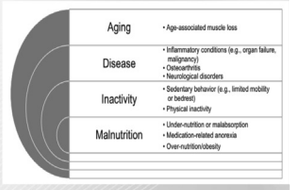
Nascimento et al., Free Radical Biology and Medicine. (2019).

Comprehensive geriatric assessment

Comprehensive geriatric assessment

- **Mechanisms of sarcopenia.**

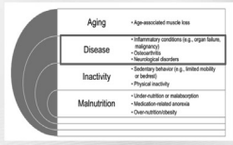




Cruz-Jentoft et al., Age and Ageing. (2010, 2019).

Comprehensive geriatric assessment

- **Disease related sarcopenia in eldery**



- Malignancy
- Hearing, visual impairment
- Hip Fx
- Cancer
- Muskuloskeletal (OA, RA, osteoporosis)
- Psychiatric issues: delirium, depression, congnitive impairment
- Neurologic disorders

Comprehensive geriatric assessment

Original article

Sarcopenia, malnutrition and cognition affect physiotherapy frequency during geriatric rehabilitation: RESORT cohort

Laure M.G. Verstraeten[a], Federica Sacchi[a], Janneke P. van Wijngaarden[b], Carel G.M. Meskers[c], Andrea B. Maier[d,e,f,g,*]

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[f] *Centre for Healthy Longevity, @AgeSingapore, National University Health System, Singapore*

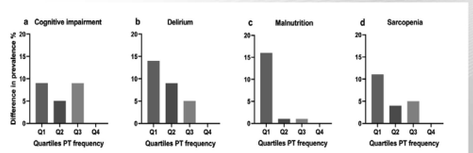
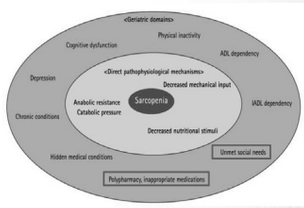


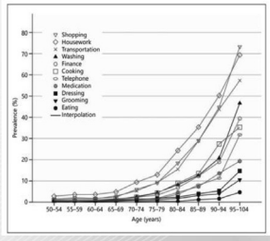
Fig. 1. Difference in prevalence of cognitive impairment (a), delirium (b), malnutrition (GLIM) (c) and sarcopenia (EWGSOP2) (d) between quartiles of physiotherapy frequency (number of sessions per week) during geriatric rehabilitation.
PT: physiotherapy; GLIM: Global Leadership Initiative on Malnutrition; EWGSOP2: revised European Working Group on Sarcopenia in Older People definition. Q4 is the reference group. Q1 = ≤3.03; Q2 = >3.03 & ≤5.20; Q3 = >5.20 & ≤7.70; Q4 = >7.70 PT sessions per week.

Verstraeten et al., Annals of PMR (2023).

Comprehensive geriatric assessment

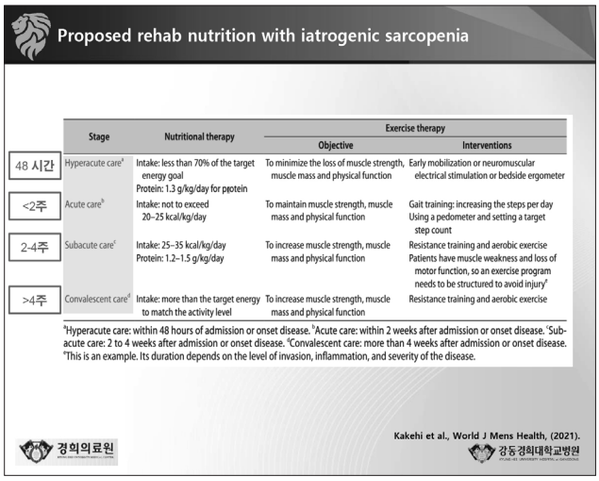
Activities of daily living, ADL





Comprehensive geriatric assessment:
personalized, multi-disciplinary approach should be considered

Baek et al., Ann Geriatr Med Res 2023;27(1):9-21


Proposed rehab nutrition with iatrogenic sarcopenia
Stage
Nutritional therapy
Exercise therapy
Objective
Interventions
48 시간
Hyperacute care[a]
Intake: less than 70% of the target energy goal
Protein: 1.3 g/kg/day for protein
To minimize the loss of muscle strength, muscle mass and physical function
Early mobilization or neuromuscular electrical stimulation or bedside ergometer
<2주
Acute care[b]
Intake: not to exceed 20–25 kcal/kg/day
To maintain muscle strength, muscle mass and physical function
Gait training: increasing the steps per day
Using a pedometer and setting a target step count
2-4주
Subacute care[c]
Intake: 25–35 kcal/kg/day
Protein: 1.2–1.5 g/kg/day
To increase muscle strength, muscle mass and physical function
Resistance training and aerobic exercise
Patients have muscle weakness and loss of motor function, so an exercise program needs to be structured to avoid injury[d]
>4주
Convalescent care[d]
Intake: more than the target energy to match the activity level
To increase muscle strength, muscle mass and physical function
Resistance training and aerobic exercise
[a]Hyperacute care: within 48 hours of admission or onset disease. [b]Acute care: within 2 weeks after admission or onset disease. [c]Subacute care: 2 to 4 weeks after admission or onset disease. [d]Convalescent care: more than 4 weeks after admission or onset disease.
[d]This is an example. Its duration depends on the level of invasion, inflammation, and severity of the disease.
Kakehi et al., World J Mens Health, (2021).
경희의료원
강동경희대학교병원

15th Congress of The Korean Society of Sarcopenia

2023년 대한근감소증학회 제15차 학술대회

소학회장

Session VI

일반 연제 발표

좌장: 황인규(중앙의대), 서대윤(인제대학교)

O-01

Gender Differences for Sarcopenia in Patients Undergoing Total Knee Arthroplasty for Advanced Knee Osteoarthritis

김기범, 손욱진
영남대학교 정형외과

Background: Most studies related to sarcopenia have focused on elderly women, and their outcomes have mostly addressed them. However, with the gradual increase in total knee arthroplasty (TKA) volume, since the number of elderly men who underwent TKA also increased, it is necessary to pay attention to the results of the elderly men group. However, few studies have been conducted on the comparison of outcomes after TKA in elderly men and women with sarcopenia and risk factors in elderly men with sarcopenia in these patients. The purpose of this study was to compare gender differences in the incidence of sarcopenia, demographic characteristics, and preoperative sarcopenic parameters in patients undergoing TKA for advanced knee osteoarthritis (OA). Moreover, we also sought to compare patient-reported outcome measures (PROMs) and the predisposing factors after TKA in patients with sarcopenia by gender through subgroup analysis.

Methods: From May 2020 to September 2022, a total of 892 patients whose body composition, muscle strength, and physical performance could be measured before primary TKA were enrolled. Sarcopenia was defined according to the Asian Working Group for Sarcopenia 2019 criteria. Patients were assessed according to the presence or absence of sarcopenia. After a two-to-one matched pair analysis for subgroup analysis, twenty-one knees in male were matched with a corresponding number of knees in female (42), resulting in a total of 63 knees. PROMs were investigated using the Knee Injury and Osteoarthritis Outcome Score, Western Ontario and McMaster Universities Osteoarthritis Index, and the Short Form-12 physical and mental component summary scores. Additionally, postoperative complications and predisposing factors for sarcopenia were evaluated.

Results: The prevalence of sarcopenia was 10.9%, and the prevalence was higher in men (19.6%) than in women (9.7%). At the six-month follow-up, patients with sarcopenia showed significantly inferior PROMs than non-sarcopenia patients, except for the pain score; However, from the 12-months follow-up, there was no significant difference between the groups. In subgroup analyses, male patients had significantly inferior PROMs up to 12 months after surgery. Moreover, there was no significant difference in systemic complications between the two groups. Multivariate binary logistic regression analysis indicated that smoking and higher mCCI were predisposing factors factors for male patients with sarcopenia.

Conclusions: The prevalence of sarcopenia was high in male patients undergoing primary TKA. Male patients had inferior PROMs compared to female patients up to 12 months postoperatively. Smoking and higher mCCI were predisposing factors for sarcopenia in male patients with advanced knee OA.

Keywords: Advanced knee osteoarthritis, Total knee arthroplasty, Sarcopenia, Patient-reported outcome measures, Male patients

O-02

Differences in Sarcopenia Status and Mortality According to Physical Activity: Results from the Korean Longitudinal Study on Health and Aging (KLoSHA)

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Purpose: There is increasing evidence that promoting physical activity (PA) can prevent sarcopenia. However, PA decreases with age, and the impact of PA intensity on health is unclear. This study investigated the relationship between the level of PA and sarcopenia, and the association between PA levels and mortality in patients with and without sarcopenia.

Methods: Data were derived from the Korean Longitudinal Study on Health and Aging. PA was classified as sedentary behavior (SB), light physical activity (LPA), or moderate-to-vigorous physical activity (MVPA). Each PA level was subdivided based on the median time spent engaged in that activity, yielding eight PA profiles. Logistic regression and Cox proportional hazard models were used to investigate the association between PA level and sarcopenia, and between PA profiles and mortality.

Results: This study included 620 participants. During follow-up, 264 (42.6%) participants died. Overall, sarcopenic participants were less physically active than non-sarcopenic participants. After multivariate adjustment, more SB and less MVPA were associated with sarcopenia and all related variables, except muscle mass. Compared with the reference, non-sarcopenic participants with lower SB and concomitantly higher MVPA had significantly lower hazard ratios for mortality, while higher LPA reduced mortality in sarcopenic participants regardless of time spent engaged in SB or MVPA.

Conclusions: PA, especially SB and MVPA, was associated with sarcopenia and related variables, but the level of PA that prevented death differed according to sarcopenia status. Our findings may help determine the optimal intensity and amount of PA.

Keywords: Sarcopenia, Mortality, Physical activity, AWGS 2019, KLoSHA

O-03

Probiotic-diet Rescues AD-related Sarcopenia via the Gut-muscle Axis in APP/PS/Tau Mice

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AD-related muscle dysfunctions are common degenerative brain disorders resulting in poor quality of life in the elderly. Probiotic diet is a potential strategy for preventing AD-related sarcopenia as evidence suggests that probiotics can enhance muscle function via the gut-muscle axis. However, the effects and mechanisms of probiotics in AD-related sarcopenia are currently unknown. In this study, we examined the effects of Lactobacillus sp. UBC23, a probiotic previously reported to improve muscle function in AD-old adult mice.

We administered Lactobacillus sp. UBC23 (1 × 108 or 1 × 109 CFU/mouse/day) by oral gavage to AD-accelerated mouse 3xAD mice for 8 weeks (8- to 32-week-old). Sixteen-week-old and 32-week-old AD mice were included as non-aged and aged controls, respectively. Muscle condition was evaluated using CONFOCAL analysis and H/E for muscle morphology, gene expressions for muscle function. Inflammatory cytokines were determined using ICC assay. The gut microbiota was analysed based on the data of 16S rRNA gene sequencing of mouse stool.

The Lactobacillus sp. UBC23 diet reduced AD-related declines in muscle mass and molecular function. The high dose of Lactobacillus sp. UBC23 diet was also associated with distinct microbiota composition as indicated by the separation of groups in the beta-diversity analysis ($P = 0.027$). Lactobacillus sp. UBC23 diet altered predicted bacterial functions based on the gut microbiota. Finally, the genera enriched by probiotics combination-dose were positively correlated with healthy muscle and physiological condition ($P < 0.05$), while the genera enriched in AD control mice were negatively associated with healthy muscle and physiological condition. Lactobacillus sp. UBC23 diet represents an active modulator that regulates the onset and progression of AD-related muscle impairment potentially via the gut-muscle axis.

Keywords: Probiotics, Gut-muscle axis, AD-related sarcopenia, Gut microbiota, Short-chain fatty acid

O-04

The Association of Periarticular Skeleltal Muscle Weakness and the Progression of Joint Damage and Pain in OA

김주령[1,2], Thi Hong Nhung Pham[1], 김현아[1*]

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Although osteoarthritis (OA) is regarded as a disease of the articular cartilage, recent research has demonstrated alterations in periarticular muscles that surround the affected joint. Here, we investigated changes in periarticular muscle during the progression of OA, as well as the cause–and–effect relationship between muscle weakness and OA, in a mouse model of OA by destabilization of the medial meniscus (DMM). Pathological phenotypes in the periarticular muscles were assessed in the early and late stages of OA by DMM. OA pathology and pain behavior in the mice after DMM induction were examined in response to periarticular muscle weakness induced by multiple rounds of barium chloride injections. The examinations were also performed in myostatin knockout mice with strengthened muscle phenotypes by muscle hypertrophy. Morphological alterations in the TA and quadriceps muscles in DMM mice included variations in muscle–fiber size, aberrant ECM deposition, inflammatory cell infiltration, and decreased muscle mass. Periarticular muscle fibers isolated from DMM mice showed reductions in the number of satellite cells and myogenic capacity of primary myoblast, as well as proliferation. DMM+muscle injury mice also showed exacerbated joint degeneration compared to the DMM vehicles. Myostatin knockout mice were characterized by attenuated OA and the complete abrogation of pain behavior after DMM. Our results suggest an association between muscle weakness and OA progression and pain.

Keywords: Osteoarthritis, Periarticular muscle weakness, Muscle atrophy, Fibrosis, Myostatin

O-05

Comparative Analysis between Bioelectrical Impedance Analysis (BIA) and Dual-Energy X-ray Absorptiometry (DXA) in the Diagnosis of Sarcopenia in the Geriatric Population with Metabolic Syndrome: Equipment-Specific Equation Development

Younji Kim, Jaewon Beom, and Jae-Young Lim

Department of Rehabilitation Medicine, Seoul National University Bundang Hospital

Objective: The interaction between metabolic syndrome and sarcopenia presents a serious health challenge for the aging population. It is increasingly recognized that metabolic syndrome, which can lead to a variety of complications, is closely linked to sarcopenia, which increases physical frailty and increases the risk of falls and fractures. The goal of this study was to compare muscle mass measurements using two different DXA machines and BIA and evaluate the accuracy of muscle mass measurements in this elderly population.

Methods: This prospective multicenter cohort study was conducted on patients with metabolic syndrome aged 60 years or older who visited a general hospital. Muscle mass was measured using BIA and two DXA devices (Hologic, GE lunar), and statistical analysis was performed for comparative validation.

Results: A cohort of 234 individuals with metabolic syndrome (average age 73.2±5.3 years) participated, with 112 using Hologic and 122 using GE lunar. Mean appendicular skeletal muscle mass (ASM) by BIA and DXA were 19.7±3.1 and 18.1±2.9kg for males, and 13.7±2.2 and 12.6±1.8kg for females, respectively. Multiple regression analyses yielded equipment-specific equations for calculating DXA-measured ASM based on BIA measurements: for total participants, DXA-ASM = 13.669 + 0.830BIA-ASM −0.072Ht − 1.349sex (R2=0.853); for Hologic, DXA-ASM = 10.869 + 1.073BIA-ASM − 0.089Ht (R2=0.912); and for GE lunar, DXA-ASM = 2.772 + 0.626BIA-ASM + 0.161BMI − 1.869sex (R2=0.895). Sarcopenia diagnosis equations using ASM/Weight, ASM/height^2, and ASM/BMI were also derived, with the most reliable being: DXA-ASM/BMI = 0.736 + 0.027BIA-ASM − 0.021BMI − 0.069sex (R2=0.827, p<0.001); for Hologic DXA-ASM/BMI = −0.005 + 0.878*BIA-ASM/BMI (R2=0.896), and for GE lunar DXA-ASM/BMI = 0.259 + 0.655*BIA-ASM/BMI − 0.076*sex (male=0, female=1) (R2=0.872). The study also found differences in prediction models between DXA machines.

Conclusion: This study significantly contributes by developing device-specific equations for sarcopenia diagnosis in the geriatric population with metabolic syndrome. The equation shows that in cases where DXA is difficult to apply, BIA can be utilized as it is a faster and more clinically accessible method. However, this study highlights the necessity for standardized equipment, given the variation in prediction formulas across different DXA devices.

Keywords: Sarcopenia, Metabolic syndrome, Bioelectrical impedance analysis, Dual-energy X-ray absorptiometry, Body composition

O-06

Comparison between Muscle Ultrasound and Bioelectrical Impedance Analysis for Evaluating Muscle Mass in Geriatric Population.

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[1]Department of Rehabilitation Medicine, Seoul National University College of medicine, Seoul National University Bundang Hospital

[2]Institute on Ageing, Seoul National University

Objective: Sarcopenia is an important public health problem of geriatric population. Dual energy X-ray absorptiometry (DXA) is used for golden standard of diagnosis for sarcopenia, but It is not portable and patient hydration status may affect the result. So, bioelectrical impedance analysis (BIA) is widely used techniques for such evaluations. Muscle ultrasound (US) is also widely used to assess both muscle quantity and quality. The validity and reliability of US to assess muscle mass in older adults has been examined in a recent systematic review. The objective of this study is to compare the body composition measurements obtained through BIA and US in the geriatric population and assess the agreement and correlation between the two methods.

Methods: A total of 166 geriatric outpatients (age ≥60 y) were enrolled in the study, retrospectively. After a comprehensive geriatric assessment, bioelectrical impedance analysis (BIA) and muscle ultrasound (US) was performed at same day. Vastus lateralis (VL), rectus femoris (RF) muscle thickness as well as the cross-sectional area (CSA), echogenicity were measured by US.

Results: A total 166 patients (66 males and 100 females; average age, 77.2 ± 10.7 years) were included in the analysis. The mean skeletal muscle index (SMI) by BIA was 6.08 ± 1.1 kg/m^2. The results revealed a moderate correlation only between SMI from BIA and CSA of RF (r=0.536), weak correlation between SMI from BIA and VL/RF thickness, CSA of VL. We tried to derive equation using simple linear regression analysis to calculate the values of skeletal muscle index (SMI) based on cross-sectional area (CSA) of rectus femoris by US. But, the R2 value was low as 0.287 ($p<0.001$).

Conclusion: This study demonstrates that although there is a moderate correlation between the results of BIA and CSA of RF measured by US, there are more further differences in the measurement values. The result show that US, which is clinically convenient and allows for repeated measurements, can be used for exact measurement for muscle thickness, CSA of leg muscles, but further study is needed for analyzing relationship with skeletal muscle index (SMI) by BIA.

Keywords: Sarcopenia, Ultrasound, Bioelectrical impedance analysis

O-07

Development of a Sarcopenia Classification Model Utilizing Smart Insole and Artificial Intelligence Pose Estimation

Short title: Artificial Intelligence Gait Analysis and Smart Insole for Sarcopenia

Shinjune Kim[1,2], Hyeon Su Kim[2], and Jun-Il Yoo[3*]

[1]Department of Education and Research, Seoul Bumin Hospital, Seoul, South Korea
[2]Department of Biomedical Research Institute, Inha University Hospital, Incheon, South Korea
[3]Department of Orthopaedic Surgery, Inha University Hospital, Incheon, South Korea

Background: The relationship between physical function, musculoskeletal disorders and sarcopenia is intricate. Current physical function tests, such as the gait speed test and the chair stand test, have limitations in eliminating subjective influences. To overcome this, smart devices utilizing inertial measurement unit sensors and artificial intelligence (AI)–based methods are being developed.

Methods: We employed cutting–edge technologies, including the smart insole device and pose estimation based on AI, along with three classification models: random forest (RF), support vector machine and artificial neural network, to classify control and sarcopenia groups. Patient data of 83 individuals were divided into train and test sets, with approximately 67% allocated for training. Classification models were implemented using RStudio, considering individual and combined variables obtained through pose estimation and smart insole measurements.

Results: Performance evaluation of the classification models utilized accuracy, precision, recall and F1–score indicators. Using only pose estimation variables, accuracy ranged from 0.92 to 0.96, with F1–scores of 0.94–0.97. Key variables identified by the RF model were 'Hip_dif', 'Ankle_dif' and 'Hipankle_dif'. Combining variables from both methods increased accuracy to 0.80–1.00, with F1–scores of 0.73–1.00.

Conclusions: In our study, a classification model that integrates smart insole and pose estimation technology was assessed. The RF model showed impressive results, particularly in the case of the Hip and Ankle variables. The growth of advanced measurement technologies suggests a promising avenue for identifying and utilizing additional digital biomarkers in the management of various disorders. The convergence of AI technologies with diagnostics and treatment approaches a promising future for enhanced interventions in conditions like sarcopenia.

Keywords: Sarcopenia, Physical function, Classification model, Pose estimation, Smart insole

P-01

Effect of Leucine-rich Protein in Parallel with Resistance Exercise on the Body Composition and Function of Elderly in Korea

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The standardized guidelines for preventing sarcopenia due to increased life expectancy are still insufficient. Therefore, this study evaluated the effects on body composition and physical function of healthy adults aged >50 years living in Korea with combined daily resistance exercise and daily intake of accessible protein supplements for 12 weeks. All subjects in this study were randomly assigned to 2 groups taking either protein powder[carbohydrate 12g, fat 3g, protein 20g, fructooligosaccharides 3g], or placebo powder [carbohydrate 38g] twice a day for 12weeks. Until the first 4 weeks, resistance exercises using the bare body were performed, and thereafter, a total of 3 sets of resistance exercises at a level that could be repeated 8–12 times were performed using a Thera-Band. Body composition analysis was measured using bio impedance analysis (BIA) and dual-energy X-ray absorptiometry (DXA). When measured by BIA, body fat mass (kg) and body fat (%) were significantly decreased and lean body mass (LBM) (kg) and skeletal muscle mass (SMM) (kg) were significantly increased in both groups, but when measured by DXA, LBM were significantly increased only in the protein powder group. In addition, the amount of LBM and SMM change measured by BIA was significantly greater in protein power group than that in the placebo powder group (LBM 0.95 ± 0.91 kg in the protein power group vs 0.38 ± 1.06 kg in the placebo powder group, p = 0.043 ; SMM 0.69 ± 0.58 kg in the protein power group vs 0.29 ± 0.65kg in the placebo powder group, p = 0.039, respectively). We conclude that older people who engage in exercises should have proper intake of protein supplements, which are effective in preventing weight loss and sarcopenia and helps improve muscle mass.

Keywords: Sarcopenia, Lean body mass, Skeletal muscle mass, Elderly

P-02

Sex Differences in Effect of Vitamin B12 Insufficiency on Sarcopenia: A Longitudinal Study

소윤수, 이종하, 유승돈, 윤동환, 김동환, 이승아, 전진만, 정승준, 유명철, 심가양, 박어진, 최성민, 김민수, 원장원[1]

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Background: Sarcopenia, defined as loss of muscle mass and either low muscle strength or low physical function, is associated with complications such as falls, fractures, frailty, and mortality in the elderly. Vitamin B12 (B12), also known as cobalamin, a water-soluble vitamin, plays an essential role in synthesizing myelin in the nervous system. Previous studies have reported that B12 insufficiency with significant nerve fiber damage often causes muscle weakness, impaired balance, gait ataxia and even is related to sarcopenia in the elderly. However, the longitudinal effect of B12 insufficiency on sarcopenia has not been performed yet. We aimed to investigate the impact of B12 levels on alterations in muscle mass, strength and physical function over two years. Method: In this two-year longitudinal study, we used data from the Korean Frailty and Aging Cohort Study; Of 3,014 aged 70–84 community-dwelling participants, 844 non-sarcopenic older adults (382 men and 462 women) who did not meet any diagnostic criteria parameters based on Asian Working Group for Sarcopenia (AWGS) were recruited (figure 1). The participants were divided into 2 groups by initial serum B12 concentration: the insufficiency group (< 350 pg/mL) and the sufficiency group (≥ 350 pg/mL). Generalized linear model analysis and logistic regression analysis were performed to evaluate the effect of initial B12 concentration on alterations of muscle mass, strength and physical function over a two-year period according to sex. Results: Baseline characteristics of non-sarcopenic participants by initial B12 level are presented in table 1. Initial short physical performance battery (SPPB) was significantly lower in the B12 insufficiency group in women. Initial handgrip strength (HGS), appendicular skeletal muscle mass index (ASMI) were not significantly different between the groups. Multivariable generalized linear model analysis showed that SPPB significantly more decreased (B estimate= −4.85, confidence interval [CI]=−9.11—−0.59) in the B12 insufficiency group than in the B12 sufficiency group. In multivariable logistic regression analysis, the B12 insufficiency was associated with significantly higher incidence of low SPPB (odds ratio [OR]=4.38, 95% [CI]=2.01–9.55) and sarcopenia (OR=5.90, 95% [CI]=1.55–22.43). However, in men, the B12 insufficiency was not significantly related to the incidence of sarcopenia (table 2). Conclusion: We found that B12 insufficiency negatively impacts physical function measured by SPPB and increases the incidence of sarcopenia only in women. However, B12 insufficiency was not associated with sarcopenia in men. Further studies are needed to confirm these findings.

Keywords: Sarcopenia, Vitamin B12

Table 1. Baseline Characteristics of Participants by Vitamin B12 Level according to Sex

Characteristics	Male			Female		
	B12 (pg/mL)		P-value	B12 (pg/mL)		P-value
	Sufficiency (≥ 350, n=366)	Insufficiency (< 350, n=40)		Sufficiency (≥ 350, n=478)	Insufficiency (< 350, n=41)	
Age, mean (SD)	75.28 (3.56)	75.49 (3.73)	0.72	**74.69 (3.53)**	**76.46 (3.60)**	**< 0.01***
BMI (SD)	25.15 (2.40)	25.90 (2.62)	0.06	**25.26 (2.70)**	**26.22 (3.34)**	**< 0.05***
Education years (n, %)						
≤ 6	91 (26.7)	11 (26.8)		240 (56.7)	16 (41.0)	
7-12	152 (44.6)	20 (48.8)	0.82	150 (35.5)	18 (46.2)	0.15
> 13	98 (28.7)	10 (24.4)		33 (7.8)	5 (12.8)	
Marriage (n, %)						
Married	314 (92.1)	38 (92.7)	0.89	213 (50.4)	20 (51.3)	0.91
Not married	27 (7.9)	3 (7.3)		210 (49.6)	19 (48.7)	
Income per month (Korean million won) (n, %)						
> 3	93 (27.3)	12 (29.3)		54 (12.8)	4 (10.3)	
1-3	144 (42.2)	12 (29.3)	0.23	126 (36.9)	15 (38.5)	0.90
< 1	104 (30.5)	17 (41.5)		213 (50.4)	20 (51.3)	
Current smoker (n, %)	31 (9.1)	5 (12.2)	0.52	1 (0.2)	0 (0.0)	0.76
Alcohol use (n, %)	241 (70.7)	28 (68.3)	0.75	**268 (63.4)**	**32 (82.1)**	**< 0.05***
Hypertension (n, %)	172 (50.4)	25 (61.0)	0.20	256 (60.5)	27 (69.2)	0.29
Dyslipidemia (n, %)	93 (27.3)	13 (31.7)	0.55	168 (39.7)	18 (46.2)	0.43
Diabetes mellitus (n, %)	70 (20.5)	13 (31.7)	0.10	**69 (16.2)**	**12 (30.8)**	**< 0.05***
Depression (n, %)	4 (1.2)	1 (2.4)	0.50	3 (0.7)	0 (0.0)	0.60
OA (n, %)	36 (10.6)	8 (19.5)	0.09	136 (32.2)	10 (25.6)	0.40
Osteoporosis (n, %)	**5 (1.5)**	**4 (9.8)**	**< 0.01***	89 (21.0)	10 (25.6)	0.50
Hb (g/dL, SD)	14.33 (1.33)	14.15 (1.09)	0.41	12.93 (1.02)	12.68 (1.37)	0.27
MMSE-KC (SD)	26.86 (2.18)	26.71 (2.41)	0.68	26.10 (2.53)	26.54 (2.29)	0.30
HGS (kg, SD)	35.58 (4.63)	35.03 (5.71)	0.48	22.96 (2.95)	22.42 (3.11)	0.28
ASMI (kg/m^2, SD)	7.71 (0.55)	7.69 (0.69)	0.84	6.16 (0.59)	6.25 (0.63)	0.35
SPPB (SD)	11.56 (0.69)	11.61 (0.70)	0.66	**11.37 (0.77)**	**11.10 (0.85)**	**< 0.05***

Abbreviations: B12, vitamin b12; BMI, body mass index; OA, osteoarthritis; Hb, hemoglobin; MMSE-KC, Mini-Mental Status Examination in the Korean version of the CERAD assessment packet; HGS, handgrip strength; ASMI, appendicular skeletal muscle mass index; SPPB, short physical performance battery.
† 1 million Korean won = approximately 900 USD

Table 2. Logistic Regression Analysis of Vitamin B12 Insufficiency (< 350 pg/ml) Predicting Sarcopenia and its Parameters according to Sex

Characteristics	Unadjusted model		Fully adjusted model	
	Male	Female	Male	Female
	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)
Muscle strength				
Low HGS†	2.26 (0.87-5.92)	1.84 (0.73-4.68)	1.87 (0.64-5.43)	1.72 (0.63-4.70)
Muscle mass				
Low ASMI†	0.58 (0.27-1.26)	1.23 (0.56-2.69)	0.51 (0.22-1.22)	1.67 (0.56-3.34)
Physical performance				
Low SPPB†	0.50 (0.11-2.15)	**4.36 (2.15-8.84)****	0.38 (0.07-1.94)	**4.38 (2.01-9.55)****
Sarcopenia††	1.27 (0.36-4.46)	**2.96 (1.05-8.39)***	0.81 (0.18-3.73)	**5.90 (1.55-22.43)***

Abbreviations: OR, odds ratio; CI, confidence interval; HGS, handgrip strength; ASMI, appendicular skeletal muscle mass index; SPPB, short physical performance battery.
The fully adjusted model was adjusted for age, body mass index, hypertension, dyslipidemia, osteoarthritis, osteoporosis, diabetes mellitus, depression, smoking history, alcohol history, number of medications, MMSE-KC score and hemoglobin.
† Low HGS, < 28 kg for men and < 18 kg for women; low ASMI, < 7.0 kg/m^2 for men and < 5.4 kg/m2 for women; low SPPB, score ≤ 9 for both sexes.
†† Sarcopenia: low ASMI (< 7.0 kg/m^2 for men and < 5.4 kg/m^2 for women) and either a low HGS (< 28 kg for men and < 18 kg for women) or low physical performance (SPPB score ≤ 9 for both sexes).
*P < 0.05
**P < 0.01

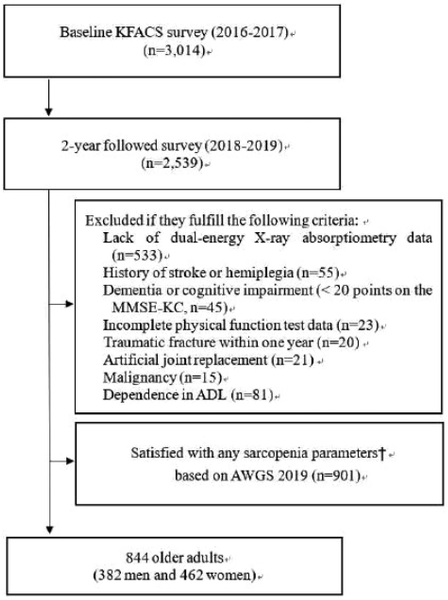

Figure 1. Flow chart of the participant recruitment process.
† Sarcopenia parameters: Low Appendicular skeletal muscle mass index (ASMI) (< 7.0 kg/m^2 for men and < 5.4 kg/m^2 for women), low handgrip strength (HGS) (< 28 kg for men and < 18 kg for women) and low short physical performance battery score (SPPB) (≤ 9 for both sexes).
Abbreviations: KFACS, Korean Frailty and Aging Cohort Study; MMSE-KC, Mini-Mental Status Examination in the Korean version of the CERAD assessment packet; ADL, Activities of daily living; AWGS, Asian Working Group for Sarcopenia.

P-03

Association of Physical Activity with Sarcopenic Obesity in Community-dwelling Older

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Introduction: Sarcopenic obesity (SO) is clinical condition characterized by the coexistence of obesity and sarcopenia, which increases the risk of synergistic complications such as frailty, disability and mortality. Previous studies have reported that overall levels of physical activity (PA) are associated with a reduced risk of developing of SO. However, the association between specific intensity of PA and SO, and the association of PA with the individual components of SO have not been well investigated. The European Society for clinical Nutrition and Metabolism (ESPEN) and the European Association for the Study of Obesity (EASO) have developed a diagnostic criteria provided a consensus definition of SO in 2022. In this study, we aimed to investigate the association between PA and the individual components of SO.

Method: In this study, we used data from the Korean Frailty and Aging Cohort Study; A total of 2,071 older adults (1,030 men and 1,041 women, aged 70–84 years) were recruited. SO was defined according to the criteria of ESPEN and EASO. Total PA per week was expressed as metabolic equivalents (METs), and three levels of PA were used to classify the participants based on the International Physical Activity Questionnaire (IPAQ). Multilogistic regression analysis was used to investigate the association between physical activity and SO.

Results: The prevalence of SO was 8.7% in men and 10.4% in women. In the multivariate analysis, high-intensity physical activity was associated with a lower risk of SO (odds ratio [OR], 0.53; 95% confidence interval [CI], 0.33–0.87 in men; OR, 0.39; 95% CI, 0.24–0.62 in women) (Table 1). Moderate-intensity physical activity was associated with a lower prevalence of SO (4.0 MET, OR=0.68; 95% CI, 0.51–0.91 in men; OR=0.83, 95% CI, 0.70–0.98 in women and 3.3 MET; OR=0.74; 95% CI, 0.58–0.95 in men; OR=0.66; 95% CI, 0.51–0.87 in women)(Table 1). High physical activity was also associated with a lower risk of low muscle mass, skeletal muscle function, and fat mass, all of which are included in the diagnostic criteria for SO (Table 2). ROC analysis revealed that energy expenditures of ≥3,032 kcal/week (433 kcal/day) in men and ≥2,730 kcal/week (390 kcal/day) in women yielded optimal results (Figure 1).

Conclusion: We found that high PA was associated with a lower risk of SO. Moderate-intensity physical activity and total physical energy expenditures of more than 3,032 kcal/week (433 kcal/day) in men and 2,730 kcal/week (390 kcal/day) in women were associated with a lower risk of SO.

Keywords: Sarcopenic obesity, Physical activity

P-04

Can We Predict Muscle Changes after 2 Years Using Gait Speed A Longitudinal Study?

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Objective: Decline of physical functions and muscle loss occur with aging. Gait speed is used as an index to assess frailty or sarcopenia. Slow gait speed is associated with higher rates of disability, hospitalization and mortality. Cut-off value of slow gait is decided as less than 1.0 m/s as suggested in Asian Working Group for Sarcopenia (AWGS) and a previous study conducted with Korean Frailty and Aging Cohort Study (KFACS). As far as we know, there was no longitudinal study that predicted muscle change after 2 years with gait speed. The objective of this study is to assess whether it is predictable that the slower gait speed, the more muscle loss occurs.

Method: This longitudinal study analyzed data from the KFACS. Among total 3,014 older people aged 70-84 years, 1,861 elderly who can walk independently were included. All participants measured the physical function of baseline and dual-energy X-ray (DEXA) to estimate changes of muscle mass over 2 years. Gait speed was obtained as a sub-parameter of short physical performance battery (SPPB), recorded time to the nearest 0.01s using laser sensor. The participants were divided into two groups, slower group (gait speed < 1m/s) and faster group (gait speed ≥ 1m/s). Generalized linear model analysis was used to evaluate the difference in percent between two groups in change of the lean mass of limbs, trunk and appendicular skeletal muscle mass index (ASMI) over 2 years.

Results: Characteristics of participants at baseline are shown in table 1. ASMI decreased by 2.73% overall after 2 years and statistically significantly decreased in slower group than in faster group (-3.41% vs. -2.48%, p=0.016). Lean mass of legs also significantly decreased in slower group (-3.98% vs. -2.84%, p=0.008). There was no significant difference between the two groups in changes of lean mass in arm, trunk and whole body (table 2).

Conclusion: In this study, the overall lean mass decreased after 2 years in the elderly. The lean muscle mass of whole body, limbs and trunk showed a tendency to decrease more in slower group (gait speed < 1m/s) than in faster group (gait speed ≥ 1m/s). The difference was significant in lower limb, ASMI and whole body. Considering that ASMI and whole body included lower limb, the present gait speed is a parameter that can predict change of muscle mass of lower extremity in 2 years.

Keywords: Gait speed, Sarcopenia

P-05

Sarcopenia Detection Technique Based on Stimulated Muscle Contraction Signal Using Wearable Device

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엑소시스템즈

Object: To detect a sarcopenia, measurements of skeletal muscle index, muscle strength, and gait speed are typically required. However, there are situations where assessing muscle strength and gait speed is not feasible due to the patient's condition. To address this issue, we propose a classification technique for the sarcopenia based on stimulated muscle contraction signals (SMCS) using wearable devices. Muscle fiber atrophy occurs due to the degeneration of the motor neurons caused by muscle atrophy [1]. For this reason, during muscle stimulation using electrical stimulation, we collect neuromuscular response signals through surface electromyography (EMG) sensors installed in the wearable devices [2], [3]. Since the collected SMCS represents the response signals of motor neurons and muscle fibers, it allows us to analyze the weakened state of the neuromuscular system due to the sarcopenia. Therefore, we propose an artificial intelligence technique using feature vectors extracted from SMCS as input for the detection of the sarcopenia.

Methods: The SMCS collected through wearable devices is composed of signals obtained by increasing the electrical stimulation frequency from 5Hz to 30Hz in 5Hz increments. Furthermore, SMCS consists of data collected for each electrical stimulation frequency over an 8-second period. Subsequently, feature vectors were extracted from each segment of SMCS through frequency transformation, and an input vector for the support vector machine (SVM) was constructed via feature selection. To validate the proposed technique, SMCS data from 133 Alzheimer's patients were collected, and labels were assigned based on Asian sarcopenia diagnostic criteria. Finally, the algorithm's performance was assessed through leave-one-out cross-validation (LOOCV).

Results: Using a database of 133 Alzheimer's patients, the results showed a model sensitivity of 86.7% and specificity of 91.1%, with an area under the receiver operating characteristic (ROC) curve of 0.92.

Conclusions: Since the SMCS proposed in this paper includes response signals of motor neurons and muscle fibers, it was possible to extract the features for bioinformation about the neuromuscular system. Moreover, experimental results showed meaningful outcomes from a detection of sarcopenia when constructing an SVM model with feature vectors extracted from SMCS. Therefore, based on the experimental findings, it is deemed feasible to diagnose muscle atrophy using SMCS.

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Keywords: Sarcopenia, Neuromuscular, SMCS, Electrical stimulation

P-06

UPT-01 Suppresses Cisplatin-induced Sarcopenia via Downregulation of Proinflammatory Cytokines and Muscle-specific Ubiquitin E3 Ligases

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Background: Cisplatin is a broad-spectrum chemotherapeutic agent used in diverse types of cancer. However, one of the common side effects of cisplatin chemotherapy is sarcopenia which is associated with decreased patient's quality of life as well as increased morbidity and mortality. This study aimed to elucidate the protective effects of the compound UPT-01 on cisplatin-induced sarcopenia.

Methods: Male C57BL/6 mice received intraperitoneal injection of cisplatin (3 mg/kg/day, 4 times) and oral administration of UPT-01 (5-20 mg/kg/day, every day). Megestrol acetate (160 mg/kg/day, every day) was used as a comparator drug. Skeletal muscle function (strength and endurance), was measured by grip strength and treadmill running distance, respectively. At the end of the study, the weight of the gastrocnemius and quadriceps muscles was measured, and gastrocnemius were analyzed using RT-qPCR, ELISA and western blot.

Results: Grip strength and treadmill running distance were decreased in the cisplatin group compared to control group, which was significantly ameliorated in the UPT-01 group. Gastrocnemius and quadriceps weights were reduced by cisplatin, which significantly was improved by UPT-01 treatment. UPT-01 suppressed cisplatin-induced elevations in TNF-α, IL-1β and IL-6 as well as the DNA binding of NF-κB in muscle. UPT-01 also reduced the skeletal muscle expression of muscle-specific ubiquitin E3 ligases, muscle ring-finger-1 (MuRF1) and muscle atrophy F-Box (MAFbx), resulting in elevations of myosin heavy chain and myoblast determination protein-1, which play crucial roles in muscle contraction and exercise-induced muscle regeneration. UPT-01 suppressed cisplatin-induced atrophy of C2C12 myotubes in vitro, which was accompanied by reductions of proinflammatory cytokines and NF-κB signaling as well as ubiquitin E3 ligase expression.

Conclusion: UPT-01 ameliorates cisplatin-induced sarcopenia via downregulation of proinflammatory cytokines, NF-κB signaling and muscle-specific ubiquitin E3 ligases, MuRF1 and MAFbx, in skeletal muscle.

Keywords: Sarcopenia,cisplatin, NF-κB, Muscle-Specific Ubiquitin E3 ligases

P-07

The Inhibition of FOXO1 Alleviates Primary Sclerosing Cholangitis (PSC)-Induced Sarcopenia

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Primary Sclerosing Cholangitis (PSC) is a cholestatic liver disease that affects the hepatic bile ducts, leading to fibrosis, inflammation, and eventual liver damage. PSC can also impact skeletal muscle through the muscle–liver axis, resulting in sarcopenia, a syndrome characterized by a generalized loss of muscle mass and strength. The underlying mechanisms of PSC–induced sarcopenia are not well understood, but one potential regulator is the transcription factor FOXO1, which is involved in the ubiquitin proteasome system. Thus, the aim of this study was to assess the pharmacological potential of FOXO1 inhibition for treating PSC–induced sarcopenia. To establish diet–induced PSC model, we provided mice with a 3,5–diethoxycarbonyl–1,4–dihydrocollidine (DDC) diet for 4 weeks. Mice were intramuscularly injected with AS1842856 (AS), a FOXO1 inhibitor, at a dose of 3.5 mg/kg twice a week. To mimic the PSC environment in vitro, C2C12 myotubes with cholic acid (CA) or deoxycholic acid (DCA) were treated with AS. We observed that DDC–fed mice were decreased in muscle size and performance, which is attenuated by administration of AS. In addition, AS improved myotube diameter and MHC protein level decreased by CA or DCA treatment, and diminished protein and mRNA expression including Atrogin–1 and MuRF1. Our study suggests that FOXO1 inhibition effectively mitigates DDC diet–induced sarcopenia in a rodent PSC model.

Keywords: Primary sclerosing cholangitis, Sarcopenia, FOXO1

P-08

Stroke-related Functional Sarcopenia is Associated with Age

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Background: "Sarcopenia" was introduced as a term to describe the age related loss of skeletal muscle. It is known that sarcopenia can occur in the presence of a stroke, with a pooled prevalence of 42% according to a previous study of stroke related sarcopenia. The prevalence of sarcopenia after stroke is high, and a previous study reported a multifactorial process that is not solely age related, as different risk factors contribute to muscle loss in the upper and lower limbs after stroke. "Functional sarcopenia" has been defined in the 2023 Korean Working Group on Sarcopenia Guideline. However, there is a lack of research on functional sarcopenia in stroke patients. Therefore, the purpose of this study is to identify functional sarcopenia in stroke patients and determine the association between stroke patients and functional sarcopenia.

Methods: This study included a total of 70 stroke patients who were hospitalized at W Rehabilitation Hospital in Gwangju. To diagnose functional sarcopenia, muscle strength was assessed using handgrip strength, and physical performance was measured using the Timed Up and Go (TUG) test. Only subjects who met the criteria of the two evaluation measures were classified as having functional sarcopenia. General characteristics of stroke patients, including Manual Muscle Test (MMT) total score, Berg Balance Scale (BBS), 10-Meter Walk (10MW) test, Functional Ambulation Category (FAC), and Modified Barthel Index (MBI), were assessed through a cross-sectional survey. The collected data in this study were analyzed using independent t-tests, chi-square analysis, and logistic regression analysis.

Results: Among the 70 stroke patients, 31 (44%) had stroke-related functional sarcopenia. When comparing the stroke group with the stroke-related functional sarcopenia group, significant differences were found in Type of stroke, Onset of stroke, Age, Weight, BBS, 10MW, FAC, and MBI ($p<0.05$). According to the logistic regression analysis, for every 1-year increase in age, the probability of belonging to the stroke-related functional sarcopenia group increased by 1.078 times ($p<0.05$).

Conclusion: The results of this study showed that functional sarcopenia in stroke patients was related to age. Previous studies have reported that stroke-related sarcopenia is not related to age. The findings of this study contradict the previous research, indicating that stroke-related sarcopenia is not related to age. Further research is needed on stroke-related functional sarcopenia.

Keywords: Sarcopenia, Functional sarcopenia, Stroke, Rehabilitation

P-09

The Prevalence and Relationship of Sarcopenia in Middle-aged Adults Undergoing THA

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Background: Most middle-aged adults with hip fractures (FX), hip osteoarthritis (OA), or hip avascular necrosis (AVN) typically undergo total hip arthroplasty (THA). Sarcopenia is not only a condition that results in a decline in physical function but also a serious pathological condition that can affect the postoperative outcomes of orthopedic surgeries. Both sarcopenia and hip disorders are associated with age-related decline in physical function. However, there is a lack of research investigating the relationship between these two conditions. Therefore, this study aimed to investigate differences in physical function among middle-aged adults with and without sarcopenia after THA.

Methods: This study included 79 middle-aged adult patients admitted to G Rehabilitation Hospital for postoperative rehabilitation after THA. Sarcopenia was diagnosed by a rehabilitation specialist (MD) based on the AWGS 2019 guidelines. Physical therapists evaluated and collected data on the general characteristics of middle-aged adults who underwent THA, as well as their MMT (Manual Muscle Test) total score, ROM (Range of Motion) total score, BBS (Berg Balance Scale), FAC (Functional Ambulation Category), and MBI (Modified Barthel Index). The data collected in this study were analyzed using independent t-tests, chi-square analysis, and logistic regression analysis.

Results: Among the 79 middle-aged adults undergoing THA, 34 (43%) had sarcopenia. The results of the comparison between the sarcopenia and non-sarcopenia groups showed significant differences in sex, reason for surgery, MMT total score, and MBI ($p<0.05$). In the logistic regression analysis, it was found that females were 4.994 times more likely to belong to the sarcopenia group compared to males in terms of sex, and the probability of belonging to the sarcopenia group was 5.090 times higher when the reason for surgery was FX compared to OA ($p<0.05$).

Conclusion: Sarcopenia exhibited a high prevalence among middle-aged adults who underwent THA. There was an association between sarcopenia and females, as well as fractures. Further research is needed to address sarcopenia in middle-aged adults who have undergone THA.

Keywords: Sarcopenia, Total Hip Arthroplasty, Middle Aged, Rehabilitation

P-10

노인성 근감소증 개선을 위한 인삼열매추출증숙분말(SGBP)의 효력 연구

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노화에 따른 골격근 위축 및 약화는 노인의 삶의 질을 저하시킬 뿐만 아니라 뿐만 아니라 기저질환의 예후도 악화시키며, 이는 수명과도 크게 연관을 보인다. 본 연구팀은 최근 인삼열매추출증숙분말(SGBP, Steamed Ginseng Berry Powder) 원료를 개발하였으며 이의 근력개선 대한 효력시험 연구를 진행하였다. 그 결과 50 또는 100 mg/kg 용량의 인삼열매추출증숙분말(SGBP)을 근감소증 유도 노화마우스에 30일 동안 매일 경구 투여한 군에서, Grip strength test에서 근력 개선 효과를 검증했으며, 조직학적 분석으로 인삼열매추출증숙분말(SGBP)을 투여한 그룹에서 근육다발의 크기가 증가하였다. 이러한 근감소증 개선 기전으로 근육 분화 바이오마커인 MyHC, MyoD, MyoG의 발현을 증가시켰고, 단백질 분해 효소인 Murf1, atrogin-1의 발현을 감소시켜 근육 재생이 촉진됨을 확인하였다. 또한, MyHC type별 mRNA를 분석한 결과 인삼열매추출증숙분말(SGBP)에 의해 근육분화를 촉진됨을 검증하였다. 따라서 인삼열매추출증숙분말(SGBP)은 근육 분화 촉진, 근감소증 유도 인자의 감소를 통해 근력 개선 및 근육 재생 효능을 검증하는 것을 확인하였다. 향후 인삼열매추출증숙분말(SGBP)을 경구 투여하더라도 노인성 근감소증을 개선하는데 도움을 줄 수 있을 것으로 판단된다.

키워드: 인삼열매추출증숙분말, SGBP, 근력개선, 근감소증, Sarcopenia

P-11

3주간의 주 2회 저항성 운동과 근육전기자극이 근 기능 개선에 미치는 효과

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서론: 전세계적으로 고령인구가 증가하고 있으며 노령인구의 증가로 인해 노화에 따른 근감소증 환자들이 증가하고 있다. 근감소증은 노화에 따라 근육량이 감소하고 신체기능이 저하되는 만성질환으로 낙상, 골절, 사망 등의 위험을 높인다. 근감소증은 빠르고 강한 수축을 통해 움직임을 수행하는 속근 섬유(Type II muscle fiber)가 감소하며, 특히 다리 근육에서 두드러진다. 근감소증의 치료를 위해서는 속근 섬유를 활성화시킬 수 있는 운동이 진행되어야 한다. 저항성 운동은 속근 섬유를 활성화시키기 위해서는 고강도 저항성 운동이 수행되어야 하기 때문에 노인 대상자들에게 부상의 위험으로 인해 제한적이며, 근육 및 신경을 전기적으로 자극하여 근육을 수축시키는 근육전기자극(Electrical muscle stimulation; EMS)은 효과적으로 속근 섬유를 활성화시켜 개선할 수 있지만 근 기능의 개선에는 효과가 미미하다는 단점이 있다. 근 기능을 효과적으로 개선하기 위해서는 EMS와 운동을 함께 적용하는 방법이 필요하다. 하지만 EMS와 운동을 함께 진행하여 근 기능의 변화를 관찰한 연구는 척수손상과 같은 신경학적 손상이 있는 대상자에게 적용하거나 전신 근육전기자극을 적용한 연구가 대부분이다. 따라서 본 연구는 근감소증 대상자에게 주로 근 감소가 발생하는 넙다리네갈래근(quadriceps muscle)에 EMS와 중강도의 운동을 함께 적용하여 근 기능의 개선을 확인하는 것을 목적으로 하였다.

방법: 체육대학 재학생을 대상으로 오른쪽 다리를 근육전기자극(EMS)과 중강도(1RM의 60%)의 저항성 운동을 적용하고 왼쪽 다리를 저항성 운동만을 진행했다. 훈련 기간은 3주로 빈도는 주 2회로 하였으며 넙다리네갈래근을 강화할 수 있는 저항성 운동(Squat, Leg-extension, Leg-press)을 진행했다. 사전 및 사후측정에서 생체전기저항분석법(Bioelectrical Impedance Analysis; BIA)과 등속성 근 기능 측정을 통하여 하지 근육의 신체구성과 근 기능을 측정하여 변화를 확인했다.

결과: 3주간의 훈련 후 EMS와 저항성 운동을 함께 진행한 오른쪽 다리와 저항성 운동만을 진행한 왼쪽 다리에서 근력이 유의하게 증가했고 신체활력 지수(Phase angle)와 근 지구력은 유의한 변화는 없었지만 증가하는 경향이 나타났다.

논의: 3주 동안 EMS와 저항성 운동을 함께 진행한 다리와 저항성 운동만을 진행한 다리에서 근력이 유의하게 증가한 것은 속근 섬유의 증가로 인한 결과로 사료되며, 근력, 신체활력지수(Phase angle) 그리고 근지구력이 EMS와 저항성 운동을 함께 진행한 오른쪽 다리에서 더 큰 증가를 보였기 때문에 이러한 방법이 근감소증 환자의 근 기능 개선에 효과적인 방법이라는 것을 시사한다.

Keywords: 근육전기자극(EMS), 근감소증, 근 기능, 신체구성

- 이 성과는 정부(과학기술정보통신부)의 재원으로 한국연구재단의 지원을 받아 수행된 연구임 (No. 2022H1D8A3038040).
- 본 연구는 연구개발특구진흥재단의 '지역혁신 메가프로젝트' 사업으로 수행되었습니다. (과제명: 해양바이오 전략소재 메타 플랫폼화 원천기술개발, 과제번호: 2023-DD-UP-0007)

P-12

Association of Hemodialysis and Sarcopenia: A Systematic Review

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This study aimed to investigate the relationship between the characteristics of hemodialysis patients and the occurrence of sarcopenia through a comprehensive literature review. A systematic literature search was conducted to identify eligible studies in the Cochrane library, PubMed and Embase. Ultimately, 16 studies met our selection criteria. Fourteen of the sixteen studies (88 %) reported that significant association between sarcopenia diagnosis and hemodialysis patients. However, two studies reported no association between sarcopenia diagnosis and hemodialysis patients. As a factor statistically related to sarcopenia in hemodialysis patients, Mortality (38 %), age (31 %), body composition(5 %), physical activity (13 %), diabetes (13 %), cardiovascular abnormalities (6 %), nutritional status (19 %), and gender (19 %). Our findings highlight the necessity of developing a physical therapy program that accurately reflects the health status of hemodialysis patients. To further investigate the association between the diagnosis of sarcopenia and hemodialysis patients. This study emphasizes the importance and potential of developing physical therapy programs that effectively address the health consequences associated with hemodialysis. The significance of this research lies in its ability to provide valuable insights and lay the foundation for future studies focused on developing preventive and therapeutic interventions targeting muscle wasting syndrome resulting from hemodialysis.

Keywords: Hemodialysis, Sarcopenia, Systematic review

P-13

Distribution of Bioelectrical Impedance Vector Analysis and Phase Angle in Korean Elderly and Sarcopenia

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This study aimed to verify whether bioelectrical impedance vector analysis (BIVA) can support the clinical evaluation of sarcopenia in elderly individuals and evaluate the relationships between phase angle (PhA), physical performance, and muscle mass. The sample comprised 134 free-living elderly individuals of both sexes aged 69-91 years. Anthropometric parameters, grip strength, dual-energy X-ray absorptiometry findings, bioimpedance analysis results, and physical performance were also measured. The impedance vector distributions were evaluated in elderly individuals using BIVA. BIVA revealed significant differences between the sarcopenia and non-sarcopenia groups (both sexes). The sarcopenia group had a significantly lower PhA than the non-sarcopenia group in both sexes ($p < 0.05$). PhA was significantly correlated with age, appendicular skeletal muscle (ASM), handgrip strength (HGS), and muscle quality in both sexes and significantly correlated with ASM/Height2 and physical performance in males. BIVA can be used as a field assessment method in elderly Koreans with sarcopenia. PhA is a good indicator of muscle strength, muscle quality, and physical performance in males. These methods can help diagnose sarcopenia in elderly individuals with reduced mobility.

Keywords: Aging, Bioelectrical impedance vector analysis, Diagnosis, Noninvasive, Phase angle

- This research was supported by ' regional innovation mega project' program through the Korea Innovation Foundation funded by Ministry of Science and ICT

- This work was supported by the National Research Foundation of Korea(NRF) grant funded by the korea government(MSIT) (No. 2022H1D8A3038040)

P-14

Oxymetholone Administration Combined with Treadmill Exercise Improves Sarcopenia in Aged Rats

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Sarcopenia, characterized by the progressive loss of muscle mass and function with aging, significantly decrease life quality especially in elderly. Insufficient exercise, protein imbalance, chronic inflammation, mitochondrial dysfunction, and apoptosis are all factors that contribute to sarcopenia. Exercise and physical activity are the most effective interventions to treat sarcopenia, and sometimes drug treatment may be helpful. Oxymetholone, one of the anabolic-androgenic steroids, promotes muscle growth by stimulating protein synthesis. Recently published papers showed that oral administration of oxymetholone increased muscle mass in a dexamethasone-induced muscle atrophy mouse model. The aim of this study is to investigate the effects of oxymetholone administration combined with treadmill exercise on sarcopenia in aged rats. SD rats aged 5 months (young) and 20 months (old) were used and divided into four groups as follows: (i) YC, young control group; (ii) OC, old control group; (iii) EX, old-exercise group; (iv) OXM, old-exercise-oxymetholone group. Exercise intervention and oxymetholone treatment resulted in significant increases in grip strength, quadriceps muscle weight, thickness, and fiber size. Additionally, it also reduced the mRNA expression levels of MuRF1 and atrogin-1, two key regulators of muscle atrophy. These findings imply that a combination of oxymetholone treatment and treadmill exercise may be effective in alleviating sarcopenia during aging. [This work was supported by the Korea Institute of Planning and Evaluation for Technology in Food, Agriculture and Forestry (IPET) through the High Value-Added Food Technology Development Program, funded by the Ministry of Agriculture, Food and Rural Affairs (MAFRA) (grant number 321024-04-1-HD020)]

Keywords: Aging, Sarcopenia, Oxymetholone, Treadmill exercise

P-15

Quercetin Ameliorates Obesity-induced Muscle Atrophy in High-fat Diet-fed Mice

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Quercetin, a polyphenolic flavonoid found in edible plant such as apples, onions, and broccoli, has been reported to ameliorate various diseases, including cancer, obesity, and non-alcoholic fatty liver disease. Skeletal muscle atrophy, which is characterized by muscle tissue loss and wasting, is closely associated with chronic diseases such as obesity. In this study, we aimed to investigate the effect of quercetin on muscle atrophy induced by a high-fat diet (HFD) in C57BL/6 mice. The mice were either fed a normal diet (ND) or a HFD for 8 weeks, followed by a 6-week oral administration of quercetin or saline while maintaining to be fed the HFD. As a result, quercetin significantly reduced body weight gain, improved grip strength, and increased the weight of four specific muscles (quadriceps femoris, gastrocnemius, tibialis anterior, and extensor digitorum longus) in mice induced by the HFD. Quercetin also altered muscle morphology affected by the HFD, including the alleviation of muscle atrophy, improved structural arrangement, and reduced interfibrous area. Additionally, quercetin decreased the mRNA expression levels of MuRF1 and Atrogin-1, both known muscle atrophy genes, in the quadriceps femoris and gastrocnemius muscles of HFD-fed mice. These findings suggest that quercetin has the potential to ameliorates HFD-induced muscle atrophy. [This research was supported by Korea Institute of Marine Science & Technology Promotion (KIMST) funded by the Ministry of Oceans and Fisheries, Republic of Korea (20220027)]

Keywords: Quercetin, Obesity, Muscle atrophy

P-16

Evaluation of Exercise and Dietary Compliance in Patients with Sarcopenia Undergoing Exercise and Dietary Intervention

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Introduction: Sarcopenia is an age-related disease in which the muscle mass and strength decreases, and it is associated with various chronic and age-related diseases, including fractures and falls. Currently, exercise and diet are the only proven interventions for sarcopenia. Therefore, for these interventions to be effective, compliance is crucial. This study evaluates exercise and dietary compliance in patients with sarcopenia undergoing a 12-week exercise and dietary intervention program.

Methods: A total of 121 participants with sarcopenia were included in this study. Participants were over 65 and less than 90 years old (42 men, 79 women, age= 74.60±5.63 years). They were randomized into intervention and a control group. Interventions included nutrition education, 12-weeks of supervised exercise training and keeping an exercise and nutrition diary. Control group only received an exercise pamphlet and were asked to keep an exercise diary. Telemonitoring was done for both groups. Changes in compliance over time was evaluated by the days of exercises per week and average compliance was also compared. Nutritional compliance was evaluated by giving scores according to the amount of protein consumed per day and the scores were summed up and converted into percentage.

Results: Throughout the intervention, both groups showed no significant difference in days of aerobic exercises per week. 92% of patients in intervention group and 75% of patients in control group had compliance of over 50%. The days of resistance exercise per week was higher for intervention group throughout the 12-week intervention period compared to the control group, but both groups showed a decline in number of resistance exercises over time. For resistance exercise compliance, 83% of the intervention group and 49% of the control group had compliance over 50%. There was no significant difference in nutrition compliance for intervention group over time.

Conclusion: A 12-week exercise and dietary intervention enables patients to have higher compliance and continue resistance exercises at home, which is important for patients with sarcopenia to gain muscle strength and muscle mass. Keeping a food diary and checking compliance help patients to maintain dietary compliance.

Keywords: Sarcopenia, Resistance training, Compliance

소학회장

Session VIII

기초/중개 연구
(Basic Research/Translational Research)

좌장: 류동렬(광주과학기술원), 송욱(서울대학교)

Curriculum Vitae

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Significance of Cellular Senescence in Sarcopenia

인하의대
강주희

The process of cellular senescence occurs due to various causes and mechanisms. Aging-related sarcopenia is caused by multiple risk factors acting on skeletal muscles over an extended period, and the accumulated cellular senescence over time can trigger and worsen muscle atrophy. In fact, when we applied anti-aging substance melatonin and/or exercise intervention to accelerated senesence mouse (SAMP8 strain) model, these interventions were shown to inhibit senescence in satellite cells and maintain their proliferation ability. These results were also confirmed in an oxidative stress-induced myoblast senescence model. Furthermore, transcriptional analysis of skeletal muscles in aged rats revealed an increased expression of various genes associated with cellular senescence. In particular, the CDKN1A gene, closely linked to aging and encoding the p21 protein, was highly upregulated in aged rats. We evaluated the effects of CDKN1A knockdown in a myoblast senescence model using ceramide to elucidate the role of CDKN1A in development of aging-related sarcopenia. Myoblast senescence was induced by ceramide, and knockdown of CDK1NA led to an increase in cell death. Interestingly, the analysis of the apoptotic cells revealed that only the senescent cells were selectively eliminated by CDK1NA knockdown. Additionally, the reduced differentiation ability of myoblasts caused by ceramide was restored by CDK1NA knockdown. These results suggest that satellite cell senescence, which plays a crucial role in the continuous regeneration of muscles, is induced by an increase in CDK1NA expression and can be a mechanism for age-related muscle atrophy. Furthermore, inhibiting CDK1NA implies the selective elimination of senescent cells and activation of muscle regeneration

Curriculum Vitae

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노화 세포 표적 발굴 및 제거의 최신 동향

한국생명공학연구원
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노화 세포는 세포 주기(Cell cycle)이 영속적으로 정지한 상태에서 주변 세포에 악영향을 미칠 수 있는 다양한 세포 외 분비물을 내는 특성을 지닌 세포다. 인간을 포함한 포유류에서 노화 세포는 나이가 들수록 다양한 조직에서 증가하며, 암, 심혈관 질환, 근감소증, 섬유증 등 여러 노인성 질환과 밀접한 관계가 있다. 유전학 방법론을 이용하여 노화 세포를 특이적으로 제거하였을때, 다양한 노인성 질환을 제어할 수 있을 뿐만 아니라 건강 수명 또한 연장할 수 있음이 밝혀지면서 노화 세포를 특이적으로 제거하여 노화 및 노인성 질환을 치료하는 약물 개발, 세놀리틱(senolytics)이 각광을 받게 되었다. 체외 배양을 통해 노화 세포가 최초로 정의되고, 노화 세포 특이적 변화와 연관된 다양한 특성에 대한 이해가 넓어졌지만 생체 내 노화 세포 축적 기전 및 노화 세포 특성에 대한 이해는 여전히 부족하다. 본 강의에서는 세포 모델을 이용하여 규명한 노화 세포의 공통적인 기전에 대해 소개하고, 현재 밝혀진 생체 내 노화 세포가 축적 기전 및 노화 세포 치료 전략의 최신 동향에 대해 소개하고자 한다. 또한 최근 수행된 단일 세포 시퀀싱 기반의 근육 손상 모델의 노화 세포 발굴 전략을 참고하여 정밀한 노화 세포 제거 전략 수립을 위해 고려되어야 할 사항에 대해서도 논의하고자 한다.

Curriculum Vitae

이현승

소속: 충남의대

| 학력사항 |

2006	가천의과대학교 의학 학사
2011	가천의과대학교 석사(내과학)
2015	카이스트 의과학대학원 박사(의과학)

| 경력사항 |

2022 – 현재	충남대학교 의과대학 내분비대사 부교수
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2015 – 2018	충남대학교병원 내분비대사 전임의

Immunosenescence in metabolic liver disease

충남의대
이현승

면역세포는 다양한 자극에 의하여 활성화되어 사이토카인 분비를 통해서 국소적, 전신적 면역반응을 매개한다. 자극이 지속되면 면역세포, 특히 T세포는 노화(senescence)와 탈진(exhaustion) 상태로 진입하고 세포자멸사(apoptosis)로 이어지게 된다. T세포의 노화와 탈진은 T세포의 면역감시(immune surveillance) 역할 감소를 통해서 암의 진행을 촉진할 뿐만 아니라 면역관문억제제(immune checkpoint inhibitor)에 대한 반응을 감소시키는 주요 기전으로 작용한다. 간은 다양한 면역세포가 존재하고 이들 면역세포는 간질환 스펙트럼에서 각각의 역할을 수행할 것으로 생각할 수 있다. 본 강의에서는 면역노화와 탈진이 지방간에서 간경변까지 진행하는 과정에서 어떠한 역할을 담당하는지 관찰하기 위해서 각각의 간질환 단계에서 T세포 노화와 탈진의 양상을 규명하는 과정을 설명할 것이다. 이를 위해서 간조직의 다양한 면역세포에 대한 유세포분석과 단일세포전사체 분석을 활용하여 T세포의 노화와 탈진의 정도를 평가하였다. 이를 통해서 본 강의는 면역반응의 변화가 대사성 간질환의 진행을 유도한다는 것을 보여줄 것이고, 대사성 간질환의 새로운 치료타겟으로써 T세포 노화와 탈진의 가능성을 제시하고자 한다.

MEMO

소학회장

Session IX

Muscle-Bone-Fat Crosstalk

Session IX

좌장: **김태영**(건국의대), **유준일**(인하의대)

Curriculum Vitae

김진우

소속: 을지의대

| 학력사항 |

2009 M.D. Degree from CHA University, Seongnam, Republic of Korea
2013 Master Degree from CHA University, Seongnam, Republic of Korea

| 경력사항 |

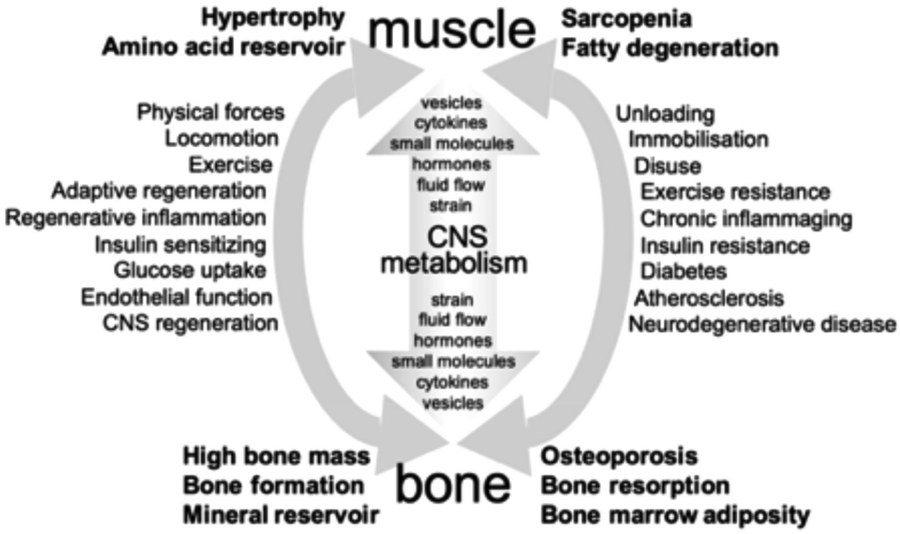
2019 – Present Assistant Professor, Nowon Eulji Medical center, Seoul
2017 – 2018 Department of Orthopaedic Surgery, Seoul National University Bundang Hospital, Seongnam
2016 – 2017 Fellowship, The Shoulder & Elbow Clinic, Dept. of Orthopaedics, Gil Medical Center, Gachon Medical School, Incheon

Bone and Muscle Interaction

을지의대 정형외과
김진우

1. Introduction

근육과 뼈는 물리적인 힘과 분비된 Osteokines과 myokines을 통해 상호 작용합니다. 물리적 힘은 중력, 운동, 운동 및 외부 장치를 통해 생성됩니다. 세포는 adhesion molecule을 통해 기계적 변형을 감지하고 이를 생화학적 반응으로 변환하여 lineage commitment, tissue formation 및 maturation과 같은 세포 생물학의 기본 메커니즘을 조절합니다. 이로 인해 bone formation, muscle hypertrophy, extracellular matrix constituents, adhesion molecule 및 cytoskeletal elements의 생산이 향상될 수 있습니다. 뼈와 근육량, resistance to strain, stiffness of matrix, cells, and tissues가 향상되어 골절 저항성과 근력에 영향을 미칩니다. 이것은 물리화학적 상호 작용의 역동적이고 지속적인 상호성을 전파합니다. 분비된 성장과 분화 인자는 상호 작용(mutual interactions)의 중요한 영향 요인입니다. 운동의 급성 효과는 근육, 뼈, 유기체 사이의 내분비 효과를 매개할 수 있는 cargo molecule을 가진 엑소좀(exosome)의 분비를 유도합니다. 장기간의 변화는 적절한 항상성을 유지하는 각 조직 분비체(secretome)의 적응을 유도합니다. Unloading, 미세중력(microgravity), 불용(disuse)의 교훈은 불필요 조직(gratuitous tissue)이 제거되거나 reorganize되는 반면, immobility와 inflammation은 근육과 골수의 지방 침투를 유발하고 근감소증과 골다공증과 같은 퇴행성 질환을 전파한다는 것을 가르쳐 준다. 현재 진행 중인 연구를 통해 예방과 치료를 위한 새로운 치료 표적을 찾을 수 있을 것입니다.



2. Interaction between Muscle and Bone의 원칙

1) 물리적 힘(Physical Forces)

(1) Forces Generated by Exercise, Locomotion, and External Vibration

(2) Mechanosensing and Mechanotransduction

2. 근골격계 근육과 뼈의 체계적인 상호작용

(1) Secretion and Autocrine/Paracrine/Endocrine Communication

(2) Bone Secretory Products with Endocrine Functions

(3) Muscle Secretory Products with Endocrine Functions

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Curriculum Vitae

전윤경

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2010 – 2014	부산대학교병원 내분비대사내과 임상부조교수

Definition and Pathophysiology of Sarco-osteoporosis

부산의대 내분비내과
전윤경

Sarco-osteoporosis is a newly described, aging-associated condition. Social frailty is an important condition whose prevalence may have risen by aging. Osteoporosis and sarcopenia are two chronic musculoskeletal conditions that can have devastating impacts both on individuals and wider society. With an ageing population, both conditions are likely to become increasingly prevalent in future, increasing the incidence of fragility fractures, and leading to greater morbidity, mortality and socioeconomic costs

Osteoporosis is defined as a 'systemic skeletal disease characterized by low bone mass and micro-architectural deterioration of bone tissue, with a consequent increase in bone fragility and susceptibility to fracture' (Consensus Development Conference, 1993). In 1994, the World Health Organization developed specific criteria to define osteoporosis in postmenopausal women, based on bone mineral density (World Health Organization, 1994)[1]

Table 1. World Health Organization classification of osteopenia and osteoporosis [1]

Table 1. World Health Organization classification of osteopenia and osteoporosis

Bone mineral density category	Definition
Normal	Bone mineral density no greater than 1 standard deviation below the reference mean (T-score ≥-1)
Osteopenia	Bone mineral density between 1 and 2.5 standard deviation below the reference mean (T-score <-1 but >-2.5)
Osteoporosis	Bone mineral density 2.5 standard deviation or more below the reference mean (T-score ≤-2.5)
Severe osteoporosis	Bone mineral density 2.5 standard deviation or more below the reference mean (T-score ≤-2.5) plus one or more fragility fractures

Bone mineral density is expressed in standard deviations relative to a sex-specific, young-adult mean (known as the T-score). From World Health Organization (1994).

Sarcopenia is an age-related condition characterized by decreased muscle mass and impaired muscle strength or physical performance[2]. There were lots of studies about sarcopenia, but the exact cut off value of muscle strength or performance were not suggested. In 2010, the original European Working Group on Sarcopenia in Older People (EWGSOP) defined sarcopenia using muscle mass and function[3], and subsequently published consensus guidelines, including the Foundation for the National Institutes of Health (FNIH)[4], Asian working group for sarcopenia (AWGS) in 2014 [5], and in 2019[6], and EWGSOP2, which generally followed a similar approach to operationalization.

Table 2. Main consensus criteria for Sarcopenia. [7]

Main consensus	Low muscle mass				Low muscle strength (grip strength)		Low physical performance
	DXA		BIA				
	Men	Women	Men	Women	Men	Women	
EWGOP	aLM/Ht^2≤7.26 kg/m^2	aLM/Ht^2≤5.5 kg/m^2	SM/Ht^2≤ 8.87 kg/m^2	SM/Ht^2≤ 6.42 kg/m^2	<30 kg	<20 kg	SPPB≤8 Gait speed<0.8 m/s
IWGS	aLM/Ht^2≤7.23 kg/m^2	aLM/Ht^2≤5.67 kg/m^2					Gait speed<1.0 m/s
AWGS	aLM/Ht^2≤7.0 kg/m^2	aLM/Ht^2≤5.4 kg/m^2	SM/Ht^2≤ 7.0	SM/Ht^2≤ 5.7 kg/m^2	<26 kg	<18 kg	Gait speed<0.8 m/s
FINH sarcopenia project	aLM/BMI<0.789	aLM/BMI≤0.512			<26 kg	<16 kg	Gait speed<0.8 m/s

DXA, dual energy X-ray absorptiometry; BIA, bioelectrical impedance analysis; EWGSOP, European Working Group on Sarcopenia in Older People; IWGS, International Working Group on Sarcopenia; AWGS, Asian Working Group for Sarcopenia; FNIH, Foundation for the National Institutes of Health; aLM, appendicular lean mass; Ht^2, height; SM, skeletal muscle; BMI, body mass index; SPPB, short physical performance battery.

In 2022, Korean Working Group on Sarcopenia Guideline were published in annals of Geriatric Medicine and Research[8]. Korean working group suggested the optimal cut off value of muscle mass,

physical performance and muscle strength with concept of functional sarcopenia according to the algorithm [Fig.1] [8].

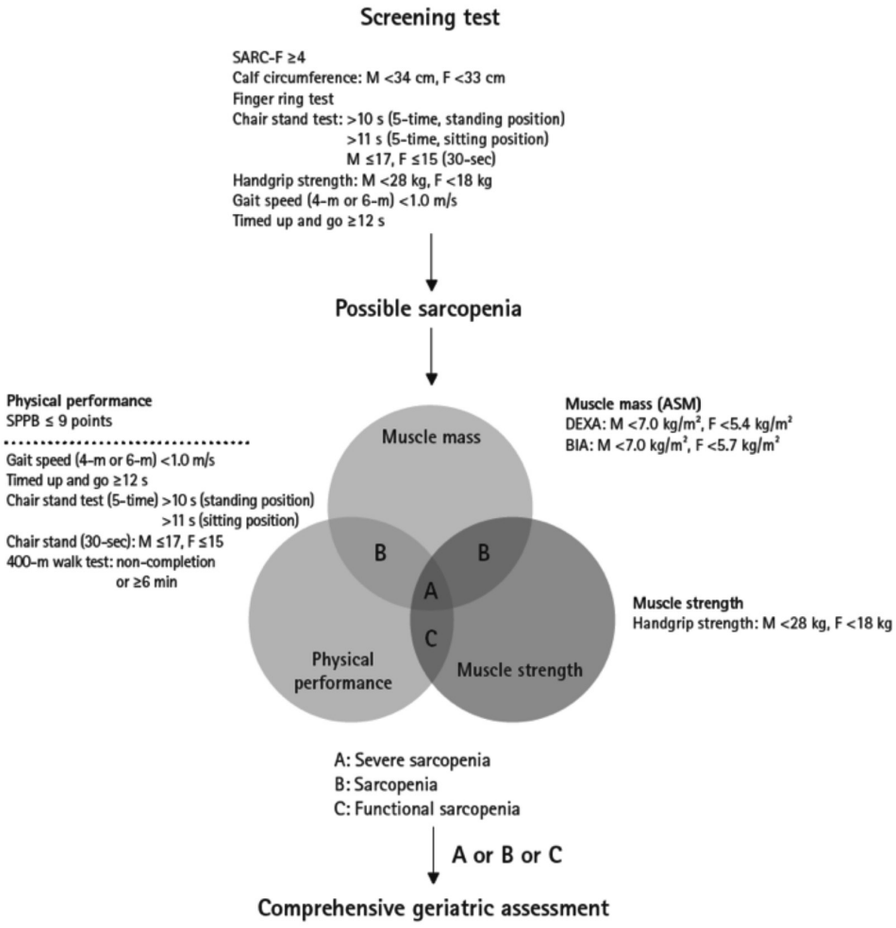

Figure 1. Algorithm for sarcopenia evaluation[8].
SARC-F, strength, assistance with walking, rising from a chair, climbing stairs, and falls; SPPB, short physical performance battery; ASM, appendicular skeletal muscle mass; BIA, bioimpedance analysis; DEXA, dual-energy X-ray absorptiometry.

To explain common pathophysiology of osteosarcopenia, various causal factors including cellular and tissue interconnection, genetic, and environment have been suggested.

Bone and muscles have an intensive and complex interaction with mechanical loading (mechanotransduction mechanism) and biochemical signaling pathways[9]. The traditional view of

the prominent mechanical interactions between muscle and bone is emphasized by the mechanostat hypothesis. This theory states that muscle imposes mechanical forces on bone, with a certain threshold dictating whether bone is formed or resorbed[10]. An increase in muscle mass leads to stretching of collagen fibers and periosteum, leading to stimulation of bone growth[11] . Bone and muscle are similarly originated from the paraxial mesoderm during embryonic development and are influenced by similar genetic factors. they share a common mesenchymal precursor and synchronously develop based on perceived mechanical stimuli.[20] Of possible genetic factors, genetic polymorphisms of angiotensin 1 converting enzyme 1, α-actinin 3 (ACTN3), myostatin, ciliary neurotrophic factor, ACTN3 polymorphism, and vitamin D receptor influence sarcopenia and osteoporosis [12,13]. Additionally, these pleiotropic regulation of genes from multiple pathways, including inflammatory, growth hormone, and steroid metabolism, leptin, transcription factor sex determining region Y-box 17, pleiotrophin, vascular endothelial growth factor, and glucocorticoid receptor are associated with muscle and bone loss [12]. Genetic factors including various gene polymorphisms have influence on susceptibility to sarcopenia and osteoporotic status [14,15]. Possible causal factors of osteosarcopenia are related with endocrine metabolism abnormality including diabetes, vitamin D deficiency, cachexia, obesity, and malnutrition [11,16].

Osteoporosis and Sarcopenia share common factors and are increasingly recognized as a ‘hazardous duet’ in the pathogenesis of fragility fractures, with the sarcopenic propensity for falls acting synergistically with the osteoporotic vulnerability of bones to increase fracture risk. More attend is need for new concept of disease entity.

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Curriculum Vitae

김홍규

소속: 울산의대

| 학력사항 |

1990	한양대학교 의과대학 학사
1997	울산대학교 의과대학원 석사
2000	울산대학교 의과대학원 박사

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2006 – 현재	서울아산병원 건강의학과 임상교수
2003 – 2005	미국 국립보건원(NIH) 연구교수
1998 – 2003	가천의대 내분비내과학 조교수
1996 – 1998	서울아산병원 내분비내과학 전임의
1992 – 1996	서울아산병원 내과 전공의

Changes in Body Composition with Aging: Visceral Fat Obesity, Low Muscle Mass, and Myosteatosis

울산의대 건강의학과
김홍규

본 연구자는 2018년부터 인공지능(artificial intelligence, AI)을 이용하여 복부 CT에서 내장지방 및 골격근량의 자동측정방법(automated measurement) 개발에 참여하면서 대규모의 건강검진 코호트에서 내장지방(visceral adiposity)과 골격근(skeletal muscle)등을 측정한 연구를 진행하였다. 또한, 골격근은 그 양(quantity)만의 측정으로는 정확한 평가가 어렵다고 판단하여 골격근의 질(quality)을 구분해서 측정하는 방법을 개발하여 다양한 연구를 해오고 있다.

본 강의에서는 먼저 연령 군에 따른 체성분의 변화와 그 유병률을 소개하고자 한다. 대사성질환과의 연관성이 가장 많이 연구된 내장지방은 남녀에 따라 그 양에 차이가 있고, 나이가 들어감에 따라서 증가되는 패턴을 보이는 것으로 알려져 있다. 그러나, 내장지방면적(visceral fat area, VFA)를 측정하는 표준 방법인 CT scan검사가 다양한 연령에서 실시되기 어렵고, 내장지방형 비만(visceral fat obesity, VFO)의 일치된 정의가 아직 없는 상태라서 그 연령에 따른 prevalence에 대한 보고는 거의 없는 상태였다. 이에 본 연구자들은 대규모 건강검진코호트에서 약 5년뒤 당뇨병발생을 예측할 수 있는 VFA의 기준을 제시하였고, 그 기준으로 VFO의 연령대별 유병률을 조사하였다.

또한, 노화에 따라 근육량이 감소되는 것으로 알려져 있지만, 막상 동양여성에서는 젊은 연령대에서 최대 근육량를 보이지 않는 관찰들이 보고되고 있는데, 이는 골격근에 대한 정확한 평가로 분석되지 않은 것이 이유라고 판단하였다. 이에, 측정한 전체 복부둘레근육을(total abdominal muscle area, TAMA)을 골격근(skeletal muscle area, SMA)과 지방(inter- or intra muscular adipose tissue, IMAT)으로 구분하고, 골격근을 density에 따라서 Normal attenuation muscle area (NAMA; good quality muscle)와 Low attenuation muscle area (LAMA; fatty muscle)로 구분하여, 그 평균 또는 median값을 연령대별 분석하였을다. 또한, 본 연구자

는 근육내 지방이 증가되는 근지방증(myosteatosis)의 정도를 정의할 수 있는 새로운 지표인 NAMA/TAMA index를 고안하였고, 이를 사용하여 myosteatosis의 연령별 분포를 분석하였다. 그리고, 이러한 평가로 근육량만으로 설명되지 않은 다양한 대사성질환에 대한 합리적인 설명이 가능함을 연구들을 통해서 증명하였고, 근감소증분야에서도 myosteatosis에 대한 평가 및 고려가 꼭 필요할 것으로 기대하게 되었다.

15th Congress of The Korean Society of Sarcopenia
2023년 대한근감소증학회 제15차 학술대회

워크숍

Session X

근감소증 평가의 실제

Session X

좌장: 임재영(서울의대)

Curriculum Vitae

임승규

소속: 순천향의대

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근감소증 진단에서 근력 측정의 실제

순천향의대
임승규

전세계적으로 빠르게 진행되고 있는 고령화 추세에 맞춰 근감소증에 대한 관심이 점차 높아지고 있으며, 정확한 진단을 위한 가이드라인 발표 및 개정이 지속되고 있다.[1,2] 특히 지역, 인종, 국가별 인구학적인 특징이 다르기 때문에, 이를 반영한 보다 세분화된 진단 기준 합의를 위한 연구 및 노력이 지속되고 있으며,[3-5] 최근 한국 상황에 맞게 사용될 수 있는 KWGS 2023 가이드라인도 발표되었다.[6] 그러나 기존의 연구나 가이드라인에서 제시된 근력과 신체 수행 능력의 측정 방법, 사용 도구, 절단 값이 서로 상이하거나, 측정 세부 내용이 명확하게 제시되어 있지 않은 부분이 있어 실제 임상 적용시 어려움이 있다. 이러한 구체적이고 명확한 측정 방법의 부재는 근감소증 진단과 유병률에 큰 영향을 줄 수 있기 때문에 이에 대한 합의 과정이 반드시 필요하다.

현재 근감소증의 근력 측정 평가는 악력 측정을 권고하고 있다. Hydraulic type (Jamar) hand dynamometer는 매우 높은 신뢰도와 타당도를 보이며, 현재 악력측정시 가장 우선적으로 사용이 권고되는 악력 측정기이다. 2011년 발표된 Southampton protocol을 현재까지는 표준화된 악력 측정 방법으로 사용하고 있으나,[7] 2022년 R. Núnez-Cortes et al. 등에 의해 발표된 체계적 문헌고찰에 따르면,[8] 여러 연구에서 사용되었던 세부적인 측정방법이 일치하지 않으며, 누락된 항목도 많음이 확인되었다.

한편 Mechanical type (Smedley, Takei) hand dynamometer도 측정치의 높은 신뢰도와 타당성을 보이고, hydraulic type hand dynamometer 와도 높은 상관관계가 있음이 확인된 악력 측정기로, 실제 임상에서 악력 측정 및 근감소증 진단시 hydraulic type hand dynamometer와 더불어 매우 많이 사용되는 악력측정기이다. 하지만, 선행 연구 결과에 의하면, 동일한 조건, 대상자에서 hydraulic type이 Mechanical type보다 더 높게 측정되어 두 악력측정기의 측정값은 일치하지 않음이 확인되었고,[9,10] 이는 서로 다른 유형의 악력측정기의 측정값을 상호 호환 적용할 수 없음을 의미한다. 그러나 실제 임상에서는 독립된 기준치를 적용하거나, 상호 보정하

는 과정이 없이 동일한 기준값, 절단값을 적용하여 근감소증 진단에 사용하고 있어,[11] 진단 자체에 매우 큰 영향을 줄 수 있는 상황이다.

악력 측정기 간의 측정치 오차 문제 이외에도, 측정 자세(앉은 자세, 선 자세), 측정값 선택(양손 측정 or 우세손 측정, 최대값 or 평균값 등), 횟수, 회복시간 등에서도 악력 측정기 간의 구분이 필요하거나, 보다 더 확실하게 기준을 정해야 할 필요가 있다. 근감소증 또는 근감소증 위험 대상자를 잘 선별해서 적절한 관리 및 중재를 하기위해서는 정확한 진단이 선행되어야 하는 것은 당연하다. 또한 추적 관찰시 경과 추적이나 의미있는 변화를 확인하기 위해서는 평가의 정확함과 일관성도 필수적이다. 따라서, 정확한 근감소증 진단을 위해서, 측정 오차를 줄일 수 있는 세분화되고 표준화된 프로토콜을 확립하기 위한 노력이 매우 필요하다.

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신체수행평가의 실제
(Physical Performance Test)

분당서울대학교병원
지명기

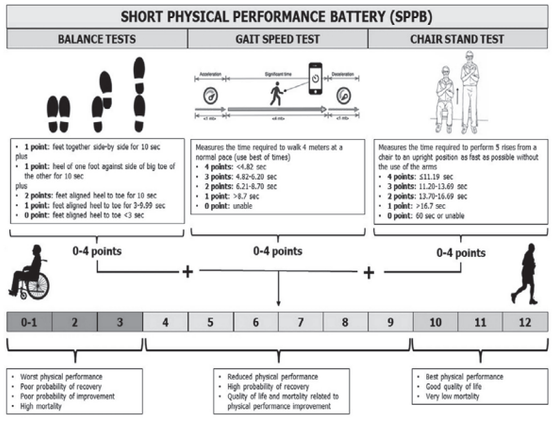
Contents

1. Short Physical Performance Test (SPPB)

- The Short Physical Performance Battery (SPPB) test is designed to measure functional status and physical performance.
  - It is a composite measure assessing gait speed, standing balance, and sit-to-stand performance.
  - It has primarily been used to assess elderly both in the hospital and community setting.
- The SPPB is calculated from three components:
  - the ability to stand for up to 10 seconds with feet positioned in three ways (side-by-side, semi-tandem, and tandem)
  - time to complete a 4m walk
  - time to rise from a chair five times.

1. Short Physical Performance Test (SPPB)

- For the standing balance tests, a score is given depending on the ability to maintain balance in each of these positions.
  For the other two tests, scores are given firstly on the ability to complete the tasks and secondly the time taken to complete each task.
- Each task is scored out of 4, with the scores from the three tests summed to give a total, with a maximum of 12 and a minimum of 0.
- The time taken to perform this test is quick; in terms of equipment it only requires the use of a standard height chair (43-45 cm, 17-18 inch high) with straight back and a stopwatch



Description and interpretation of SPPB scale. (Tonet, et al. 2023)

1. Short Physical Performance Test (SPPB)

- Lower scores on the SPPB have been shown to be predictive of
  - an increased risk of falling,
  - loss of independence in activities of daily living,
  - decreased mobility,
  - disability,
  - decline in health,
  - re-hospitalization,
  - increased hospital length of stay,
  - and death.

1. Short Physical Performance Test (SPPB)

- The SPPB has been shown to have a high level of validity and reliability in measuring physical function within an older community-dwelling population. (Freiberger, et al. 2012)

Cut-offs for sarcopenia	SPPB	Gait speed	Chair stand test
AWGS (Asian working group for sarcopenia)	≤ 9points	≤ 1.0m/s	≥ 12seconds
EWGSOP2 (European working group on sarcopenia in older people 2)	≤ 8points	≤ 0.8m/s	>15seconds
KWGS (Korean working group on sarcopenia)	≤ 9points	< 1.0m/s	>11seconds

Chen, et al. 2020, Cruz-Jentoft, et al. 2019, Beak, et al. 2023

SCORING:

A. Side-by-side-stand
Held for 10 sec ❒ 1 point
Not held for 10 sec ❒ 0 points
Not attempted ❒ 0 points
If 0 points, end Balance Tests

Number of seconds held if less than 10 sec: ___._ _sec

If participant did not attempt test or failed, circle why:
Tried but unable 1
Participant could not hold position unassisted 2
Not attempted, you felt unsafe 3
Not attempted, participant felt unsafe 4
Participant unable to understand instructions 5
Other (specify) _____ 6
Participant refused 7

B. Semi-Tandem Stand
Held for 10 sec ❒ 1 point
Not held for 10 sec ❒ 0 points
Not attempted ❒ 0 points *(circle reason above)*
If 0 points, end Balance Tests

Number of seconds held if less than 10 sec: ___._ _sec

C. Tandem Stand
Held for 10 sec ❒ 2 points
Held for 3 to 9.99 sec ❒ 1 point
Held for < than 3 sec ❒ 0 points
Not attempted ❒ 0 points (circle reason above)

Number of seconds held if less than 10 sec: ___._ _sec

D. Total Balance Tests score_____(sum points)

https://geriatrictoolkit.missouri.edu/

GAIT SPEED TEST SCORING:

Length of walk test course: Four meters ❒ Three meters ❒

A. Time for First Gait Speed Test (sec)
1. Time for 3 or 4 meters __ __._ __sec
2. If participant did not attempt test or failed, circle why:
   Tried but unable 1
   Participant could not walk unassisted 2
   Not attempted, you felt unsafe 3
   Not attempted, participant felt unsafe 4
   Participant unable to understand instructions 5
   Other (Specify) _____ 6
   Participant refused 7
   Complete score sheet and go to chair stand test

3. Aids for first walk.....None ❒ Cane ❒ Other ❒

What is the time for the faster of the two walks?
Record the shorter of the two times __ __._ __ sec
[If only 1 walk done, record that time] __ __._ __ sec

If the participant was unable to do the walk: ❒ **0 points**

For 4-Meter Walk:		**For 3-Meter Walk:**	
If time is more than 8.70 sec:	❒ **1 point**	If time is more than 6.52 sec:	❒ **1 point**
If time is 6.21 to 8.70 sec:	❒ **2 points**	If time is 4.66 to 6.52 sec:	❒ **2 points**
If time is 4.82 to 6.20 sec:	❒ **3 points**	If time is 3.62 to 4.65 sec:	❒ **3 points**
If time is less than 4.82 sec:	❒ **4 points**	If time is less than 3.62 sec:	❒ **4 points**

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SCORING
Single Chair Stand Test

	YES	NO
A. Safe to stand without help	❒	❒

B. Results:

Participant stood without using arms	❒	→ Go to Repeated Chair Stand Test
Participant used arms to stand	❒	→ End test; score as 0 points
Test not completed	❒	→ End test; score as 0 points

C. If participant did not attempt test or failed, circle why:
Tried but unable 1
Participant could not stand unassisted 2
Not attempted, you felt unsafe 3
Not attempted, participant felt unsafe 4
Participant unable to understand instructions 5
Other (Specify) _____ 6
Participant refused 7

Scoring the Repeated Chair Test
Participant unable to complete 5 chair stands or completes stands in >60 sec: ❒ 0 points
If chair stand time is 16.70 sec or more: ❒ 1 points
If chair stand time is 13.70 to 16.69 sec: ❒ 2 points
If chair stand time is 11.20 to 13.69 sec: ❒ 3 points
If chair stand time is 11.19 sec or less: ❒ 4 points

https://geriatrictoolkit.missouri.edu/

2. Timed up and go test (TUG)

- The Timed Up and Go (TUG) test is a physical performance-based measure that identify mobility and balance impairments in older adults.
- This test requires balance, sit to stand, walking, and turning.
  Subjects are asked to rise from a standard armchair, walk to a marker 3m away, turn, walk back, and sit down again.
- The test's score is the time it takes to complete the test.
- The advantages of the TUG test are the simplicity in its application and its short duration.

2. Timed up and go test (TUG)

- Materials and Methods
  - a standard arm chair (seat height of 46 cm, arm height 65 cm)
  - walk a distance of 3 meters
  - The subject wears their regular footwear and uses their usual walking aid (none, cane, walker).
  - No physical assistance is given.
  - They start with their back against the chair, their arms resting on the armrests, and their walking aid at hand.
  - They are instructed that, on the word **"go"** they are to get up and walk at normal pace to a line on the floor 3 meters away, turn, return to the chair and sit down again.

2. Timed up and go test (TUG)

- If the SPPB is not executable, TUG test can be used as an alternative.
- Since sarcopenia is a complex system in line with the concept of frailty, the TUG can be a good marker of physical performance.

Cut-offs for sarcopenia	Timed up and Go (TUG) test
EWGSOP2 (European working group on sarcopenia in older people 2)	≥ 20 seconds
KWGS (Korean working group on sarcopenia)	≥ 11.8 seconds for men ≥ 12.5 seconds for women ≥ 12 seconds for both sexes

Cruz-Jentoft, et al. 2019, Beak, et al. 2023

SAMPLE TEST FORM

TIMED UP AND GO/TUG TEST TO PREDICT RISK OF FALLS

DATE: _____

NAME: _____ GENDER: ____ DATE OF BIRTH: _____ AGE: _____

NORMATIVE DATA[1]

AGE	GENDER	MEAN (seconds)	NORMAL RANGE (seconds)
60-69	MALE	8	4-12
60-69	FEMALE	8	4-12
70-79	MALE	9	3-15
70-79	FEMALE	9	5-13
80-89	MALE	10	8-12
80-89	FEMALE	11	5-17

Sensitivity and Specificity[2]:

If score < 14 seconds: 87% not a high risk of falls
If score ≥ 14 seconds; 87% high risk of falls

Instructions to patient: "On the word 'go' you are to get up and walk at a comfortable and safe pace to the line/cones 3 meters away, turn, return to the chair, and sit down again."

Observations may include (but are not limited to): quality of sitting and standing balance, safety during transfers, quality of gait, use of assistive device, ability to turn and change direction, activity tolerance, functional visual deficits, cognition: memory and safety awareness, footwear, any loss of balance episodes

TRIAL 1: _____ seconds OBSERVATIONS:

TRIAL 2: _____seconds OBSERVATIONS:

AVERAGE: _____seconds

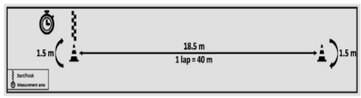
Jacobs and Tim. 2008

3. 400m walk test

- The 400m walk test with usual pace is to measure mobility limitations. Usual gait speed is recognized as a vital sign. Mobility limitation can be defined as inability to walk 400 m.
- The mobility outcome based on the 400 m walk test is an objective, reliable, well-validated and important clinical and public health outcome in older people. (Pahor, et al. 2014)
- The 400m walk test has the advantage of evaluating endurance and walking ability. Assessing how far individuals can walk outdoor is critical as it is directly related to individual quality of life.

3. 400m walk test

- This test consists of 10 laps over a 20 m course marked by two cones, placed 18.5 m apart, as an average turning distance 1.5m was assumed.



- The objective is to complete the 400m at a usual pace without overexertion.
- The instruction: "This is not a fitness test. Please walk at a speed as if you were taking a stroll in the park"
  Participants is asked to wear their own habitual outdoor shoes and use their assistive devices. (Lindemann, et al. 2021)

3. 400m walk test

- Participant can pause to rest whenever necessary and the number of rests, taken while standing without touching the walls, is recorded.
- The test is aborted at any time if requested or at signs of overexertion.
- Total time of the 400MWT and each individual lap is assessed by stopwatch and mean gait speed is calculated.
  In the case of non-completion, gait speed is obtained from the distance and time walked until drop-out.

3. 400m walk test

- Completing the walk in > 6 minutes would be in an extremely slow pace (<0.45 m/sec), which is of little utility in daily life. (The inability to complete a 400 m walk test within 6 min. without sitting rest or assistance of another person) (Newman, et al. 2006)

Cut-offs for sarcopenia	400m walk test
EWGSOP2 (European working group on sarcopenia in older people 2)	Non-completion or ≥ 6 min for completion
KWGS (Korean working group on sarcopenia)	Non-completion or ≥ 6 min for completion

Cruz-Jentoft, et al. 2019, Beak, et al. 2023

3. 400M Walking Test

1) 심장박동수 (회) 시작 전 _____ 시작 후 _____
2) 400m 걷기 성공여부 ○ Yes ○ No
3) 총 검사 시간 _____ sec
4) 평균속도 _____ m/sec

5) 검사 성공하지 못할 시, 중단 시점까지의 거리 _____ m
6) 검사 중 휴식 여부 ○ 1회 ○ No rest ○ Failed

● Comment

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MEMO

Curriculum Vitae

심가양

소속: 경희의대

| 학력사항 |

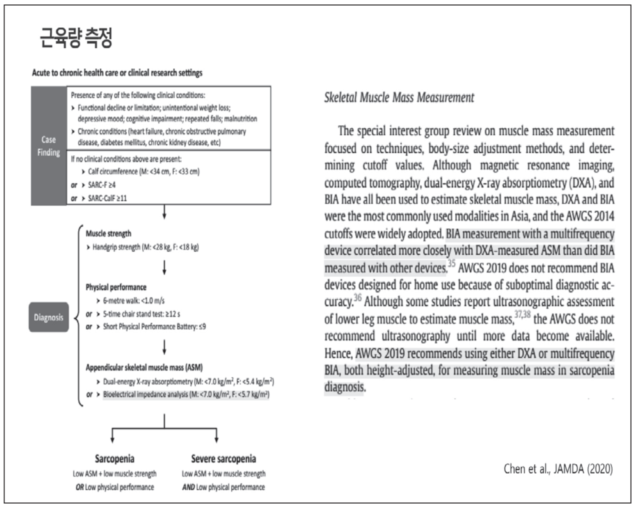
2015	Kyung Hee University, Medical School M.S.
2021	Kyung Hee University, School of Medicine, Ph.D. Rehabilitation Medicine

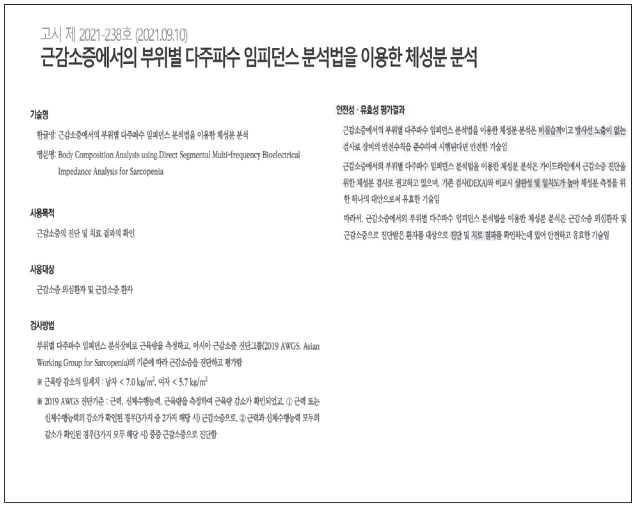
| 경력사항 |

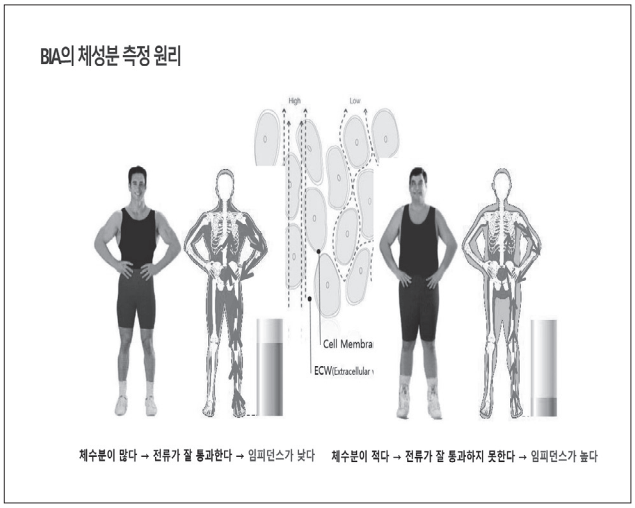
2023 – Present	Clinical Assistant Professor, Department of Physical and Rehabilitation Medicine, Kyung Hee University Hospital
2022 – 2023	Clinical Fellow, Department of Physical and Rehabilitation Medicine, Kyung Hee University Hospital
2021 – 2022	Clinical Fellow, Department of Physical and Rehabilitation Medicine, Seoul National University Bundang Hospital
2017 – 2021	Residency, Department of Physical and Rehabilitation Medicine, Seoul Medical Center
2016 – 2017	Intership, Seoul Medical Center

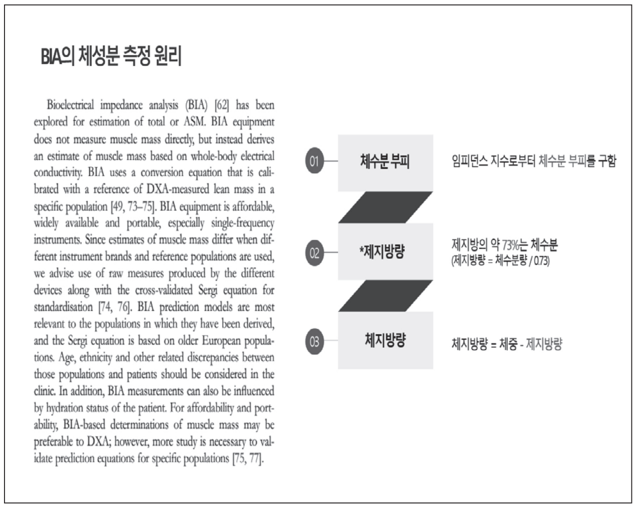
체성분 분석의 결과 해석 및 활용

경희의대
심가양



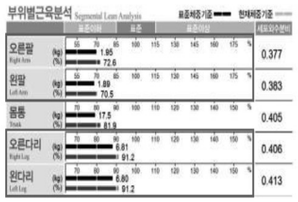




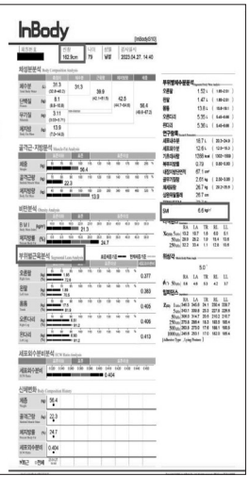


BIA를 이용한 근감소증 진단

Ex) 77세 남자, 고혈압, 당뇨, 고지혈증 기저질환 있으신 분으로, 심부전, 관상동맥경화증으로 심장내과 f/u 중, 다리힘이 빠지며, 보행장애 호소하여 근감소증 평가 및 치료 위해 재활의학과 의뢰



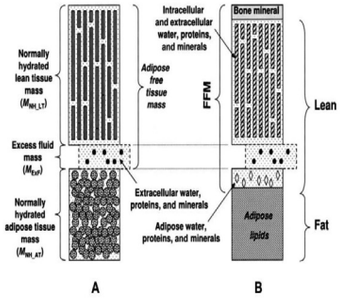
$[(1.95+1.89)+(6.81+6.80)]/1.629^2=6.57 kg/m^2$



BIA 근육량 평가시 유의점

1. 반드시 맨발로 측정해야 한다.
2. 운동 전에 측정해야 한다.
3. 샤워 또는 목욕 전에 측정해야 한다.
4. 체온 변화가 나타나지 않도록 상온에서 측정해야 한다.
5. 인바디 검사는 공복 상태로 측정해야 한다.
6. 인바디 검사는 화장실을 다녀온 후 측정해야 한다.
7. 월경기간을 피해야 한다.
8. 신장과 체중이 달라지면 체성분 측정값도 달라진다.

BIA 결과 해석 시, 유의점 (ECW/TCW)

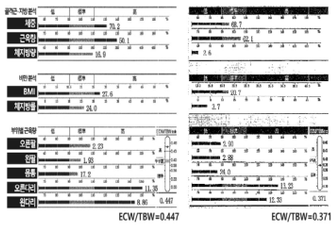


Chamney et al., Am J Clin Nutr (2007)

BIA 결과 해석 시, 유의점 (ECW/TCW)

Ex) 64세 여자, 좌측 하지 림프부종으로 체성분 분석 시행

BIA 결과 해석 시, 유의점 (ECW/TCW)

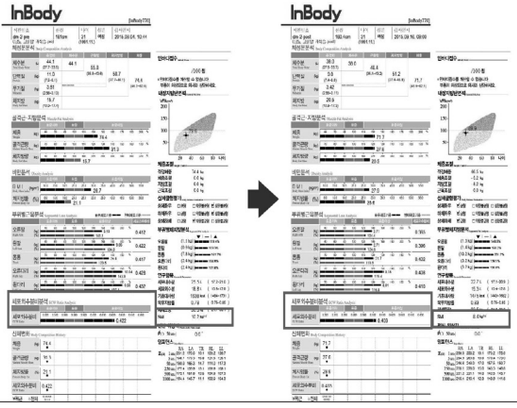


심부전 환자

축구 선수

BIA는 세포외수분비의 결과를 통해 과수화 상태에서 근육량이 과대평가되는 것을 확인할 수 있음.

BIA 결과 해석 시, 유의점 (ECW/TCW)



MEMO

Curriculum Vitae

김아셀

소속: 분당서울대학교병원

| 학력사항 |

연세대학교 물리치료학과 학사
연세대학교 일반대학원 석사(물리치료학과)

| 경력사항 |

2019 – 현재	분당서울대학교병원 재활의학과 물리치료사
2014 – 2018	서울재활병원 치료과 물리치료사
2013 – 2014	분당서울대학교병원 재활의학과 물리치료사(인턴)

평가 실습: KWGS를 기준으로

분당서울대학교병원
김아셀

실습 구성

SNUH 분당서울대학교병원

- Muscle strength – Hand grip strength
- Physical performance test
  - Short Physical Performance Battery (SPPB)
    - Balance
    - Short distance gait (4m)
    - 5x chair stand
  - Timed up and go
  - Long distance gait (400m)

들어가기 전에

SNUH 분당서울대학교병원

- 주 검사 대상의 특성을 고려할 것
  - 저하된 신체 수행 능력
    - ➢치료사의 Demonstration이 필요, 간단한 연습 시간 제공이 필요
  - 저하된 신체 기능(청력 저하 등)의 가능성
    - ➢적절한 구두 안내 (목소리의 크기, 문장의 길이, 말하는 쪽 등)
  - 저하된 내적 동기
    - ➢적극적인 독려와 격려!

Hand grip strength (HGS, 악력)

SNUH 분당서울대학교병원

Spring type (Takei)
- 바로 선 자세
- 팔꿈치 폄
- 선 자세 유지 어려울 시 앉기 허용

Hydraulic type
- 의자에 앉은 자세
- 팔꿈치 90도 굽힘

- 방법
  - 양손 혹은 우세 손으로 측정
  - 시간보다 최대 수축이 더 중요
  - 2-3회 측정 결과 중 최고 값을 대푯값으로 사용 (최소 2회)
- Diagnostic cutoffs
  - 28.0kg 미만 (남성)
  - 18.0kg 미만 (여성)
  - * 장비 별 cutoff values는 현재까지 구분되지 않음 (Jamar가 대체로 높게 측정됨)

Hand grip strength (HGS, 악력)

SNUH 분당서울대학교병원

- 구두 명령 예문 (Takei 사용)

1. 안녕하세요, 저는 000님의 악력을 측정할 물리치료사 (혹은 개인별 직종) 000 입니다.
2. 악력은 양 손을 모두 측정하며, 그 중 최대 수치를 결과로 사용합니다.
   - 뇌졸중, 관절염 등으로 양 손 모두 측정이 어려울 때 한 손만
3. 이 기구(Takei)를 사용하며, 한 번 손잡이를 잡아볼까요?
4. 최대한 힘이 들어가 지시나요? (if no -> 손잡이 조절)
5. 바로 설 수 있다면, 자리에서 일어나세요. 어렵다면 앉아도 됩니다.
6. 팔은 팔꿈치를 펴고 몸 옆에 편하게 붙이세요.
7. 이제 다시 악력기를 손에 쥐어 드렸습니다. 최대한 악력기를 쥐어 보세요.
8. 반대손을 해볼까요? (양 손 각 3회 반복)
9. 모든 검사가 종료되었습니다. 불편한 곳은 없으시죠? 이제 이동하겠습니다.

Hand grip strength (HGS, 악력)

SNUH 분당서울대학교병원

• 실습 참고 수치 (한국인 대상 자료, Takei로 측정)

Table 3. The Normative Value of Grip Strength Adjusted for All Covariates in Male.

Age Level (years)	Right Grip (kg)	Left Grip (kg)
10–19	35.76 ± 1.21 (33.37–38.14)	34.5 ± 1.08 (32.37–36.63)
20–29	39.25 ± 0.8 (37.67–40.82)	36.24 ± 0.72 (36.82–39.66)
30–39	42.07 ± 0.82 (40.45–43.69)	41.06 ± 0.75 (39.59–42.53)
40–49	41.67 ± 0.75 (40.19–43.15)	40.96 ± 0.67 (39.65–42.27)
50–59	40.24 ± 0.73 (38.8–41.68)	39.86 ± 0.64 (38.59–41.13)
60–69	38.8 ± 0.7 (37.42–40.17)	38.31 ± 0.65 (37.03–39.6)
≥70	35.14 ± 0.76 (33.64–36.65)	35.04 ± 0.65 (33.76–36.31)

Values are numbers and depicted as the mean ± standard error (95% confidence interval).

Table 4. The Normative Value of Grip Strength Adjusted for All Covariates in Female.

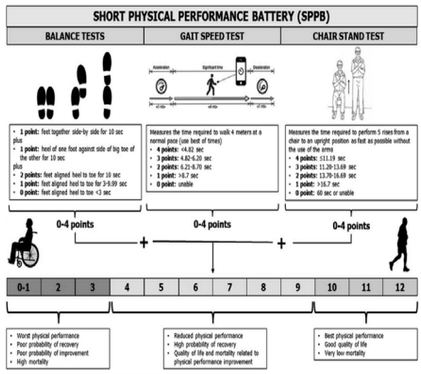
Age Level (years)	Right Grip (kg)	Left Grip (kg)
10–19	24.61 ± 0.85 (22.95–26.26)	23.23 ± 1.01 (21.75–25.72)
20–29	23.33 ± 0.48 (22.39–24.47)	22.71 ± 0.5 (21.74–23.69)
30–39	25.65 ± 0.42 (24.82–26.48)	24.95 ± 0.45 (24.07–25.83)
40–49	26.98 ± 0.44 (25.32–26.84)	25.33 ± 0.44 (24.46–26.2)
50–59	25.72 ± 0.42 (24.89–26.55)	24.72 ± 0.42 (23.89–25.55)
60–69	24.56 ± 0.42 (23.73–25.39)	23.78 ± 0.43 (22.94–24.62)
≥70	21.98 ± 0.59 (20.81–23.15)	22.05 ± 0.54 (20.99–23.11)

Values are numbers and depicted as the mean ± standard error (95% confidence interval).

(Lim SH, Kim YH and Lee JS. 2019)

Short physical performance battery

SNUH 분당서울대학교병원



(Tonet et al., 2023)

Short physical performance battery

SNUH 분당서울대학교병원

• Training videos (sppbguide.com)

BALANCE TESTS

• **1 point:** feet together side-by side for 10 sec
plus
• **1 point:** heel of one foot against side of big toe of the other for 10 sec
plus
• **2 points:** feet aligned heel to toe for 10 sec
• **1 point:** feet aligned heel to toe for 3-9.99 sec
• **0 point:** feet aligned heel to toe <3 sec

항목	점수
일반 자세	0점, 1점 (10초)
반 일렬 자세	0점, 1점 (10초)
일렬자세	0점, 1점(3-9.99초), 2점 (10초)
총합	4점

Short physical performance battery

SNUH 분당서울대학교병원

• 구두 명령 예문 (균형검사)

1. 안녕하세요, 저는 000님의 균형 능력을 측정할 물리치료사(혹은 개인별 직종) 000 입니다.
2. 제가 보여드리는 동작들을 10초 씩 해보겠습니다. (각 동작을 시범 보인다.)
3. 2-3초간 각 동작들을 연습할 수 있도록 한다. (모든 검사간 검사자는 평가자 옆에 서 있는다, 필요하다면 보행벨트를 사용한다; 보조가 필요한 경우 검사자가 도움을 최소한으로 제공할 수 있다.)
4. 첫 번째 동작 해보겠습니다. 양 발을 모아주세요. "준비, 시작", 10초가 지나면 "그만"
5. 잘 하셨습니다, 어지러우세요? 잠시 앉을까요?. 괜찮으시면 다음 동작 하겠습니다. / 10초 수행 불가 시 이후 검사 0점, 보행 검사 진행
6. 두 번째 동작 해보겠습니다. 한 쪽 뒤꿈치를 반대 발 엄지발가락 옆에 놓고 서세요. 몸을 써도 되지만, 발을 때면 안 됩니다. "준비, 시작"
7. 잘 하셨습니다. 어지러우세요? 잠시 앉을까요?. 괜찮으시면 다음 동작 하겠습니다. / 10초 수행 불가 시 이후 검사 0점, 보행 검사 진행
8. 자 이제 마지막 동작입니다. 한 발을 반대 발 바로 앞에 두고 서세요. 신발 끝과 끝이 닿아야 해요. "준비, 시작"
9. 잘 하셨습니다. 어지러우세요? 잠시 앉을까요?. 검사가 종료되었습니다. / 10초 수행 불가 시 0점, 보행 검사 진행

Short physical performance battery

SNUH 분당서울대학교병원

• 참고치

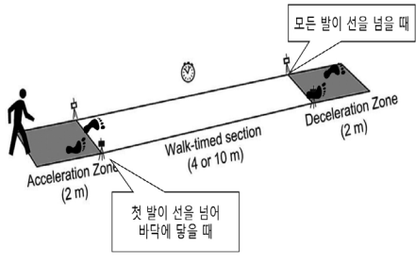
Table 3 Mean (SD) characteristics of sarcopenic and severe sarcopenic men and women aged ≥60 years according to each AWGS19 physical performance definitions for sarcopenia, including 6 m Gait Speed (GS), 5x repeated-chair Sit-to-Stand (STS) and Short Physical Performance Battery (SPPB)

	Sarcopenia			Severe Sarcopenia		
	AWGS19 GS	AWGS19 STS	AWGS19 SPPB	AWGS19 GS	AWGS19 STS	AWGS19 SPPB
Males						
n	29	34	33	27	11	8
Age (years)	74 (7)	76 (7)	76 (7)	78 (7)	78 (7)	80 (8)
Height (m)	1.62 (0.05)	1.62 (0.07)	1.61 (0.07)	1.62 (0.06)	1.65 (0.07)	1.63 (0.10)
Weight (kg)	60.2 (6.3)	59.5 (7.7)	59.0 (6.5)	61.1 (8.2)	64.1 (8.5)	64.1 (11.2)
BMI	22.9 (1.2)	22.7 (2.2)	22.6 (2.1)	23.4 (2.9)	23.8 (3.7)	24.2 (4.1)
ALM/h^2	6.1 (0.5)	5.9 (0.5)	5.9 (0.5)	6.0 (0.5)	6.0 (0.5)	5.9 (0.6)
Hand Grip (kg)	28.7 (5.2)	25.0 (6.8)	23.2 (3.9)	21.5 (4.7)	20.8 (4.1)	20.0 (6.3)
Gait Speed 6 m (m/s)	0.95 (0.15)	0.93 (0.20)	0.90 (0.17)	0.83 (0.19)	0.75 (0.15)	0.66 (0.14)
SPPB score	11.4 (1.5)	11.0 (1.6)	11.1 (1.5)	10.3 (1.9)	9.0 (2.0)	8.0 (1.7)
Females						
n	42	28	35	24	11	2
Age (years)	75 (7)	76 (6)	78 (6)	80 (6)	81 (4)	84 (0)
Height (m)	1.53 (0.04)	1.51 (0.06)	1.51 (0.06)	1.50 (0.06)	1.52 (0.04)	1.54 (0.04)
Weight (kg)	52.6 (6.6)	51.6 (7.5)	51.7 (7.8)	52.3 (8.0)	53.4 (8.0)	50.3 (6.4)
BMI	22.5 (2.7)	22.6 (2.9)	22.7 (3.1)	23.2 (2.8)	23.1 (3.1)	21.5 (3.7)
ALM/h^2	4.9 (0.3)	4.8 (0.4)	4.8 (0.4)	4.8 (0.3)	4.8 (0.4)	4.7 (0.7)
Hand Grip (kg)	20.5 (4.2)	16.5 (3.2)	16.1 (2.5)	15.5 (1.9)	15.3 (1.6)	12.8 (0.1)
Gait Speed 6 m (m/s)	0.93 (0.15)	0.90 (0.16)	0.89 (0.17)	0.87 (0.15)	0.86 (0.13)	0.65 (0.01)
SPPB score	11.3 (1.7)	11.0 (1.5)	10.9 (1.4)	10.7 (1.5)	9.7 (1.7)	6.5 (0.7)

(Lee et al., 2021)

Gait speed test

SNUH 분당서울대학교병원



(Karpman et al., 2014)

Gait speed test

SNUH 분당서울대학교병원 SEOUL NATIONAL UNIVERSITY BUNDANG HOSPITAL

- 보행 시작 방법?
- 평가 속도

Table 2
Measurement of Physical Performance for Sarcopenia Diagnosis and Gait Speed Measurement Protocols

Study Design	Types of Physical Performance	Gait Speed Measurement Protocols: Starting Method	Usual or Fastest Speed	Walk Distance, m	Cutoff, m/s	Data Sources: Author, Year[ref]
Cross-sectional	Gait speed only	Moving	Usual	6.0	0.8	Tanishima, 2017[S5]; Toyoshima, 2017[S13]; Fukuoka, 2019[S26]
				5.0	0.8	Matsumoto, 2019[46]; Ida, 2017[S36]
				5.0	1.26	Ishii, 2016[47]
			NR	5.0	0.8	Toyoda, 2019[S25]
		NR	Usual	6.0	0.8	Wang, 2018[S3]; Chen, 2019[S28]; Zhai, 2018[S29]; Lu, 2019[S37]
				5.0	NR	Yang, 2017[S38]
				4.0	0.8	Meng, 2017[S39]
				10.0	0.8	Yanishi, 2017[S40]
			NR	6.0	0.8	Yang, 2018[24]; Yang, 2019[25]; Yang, 2018[S41]; Zeng, 2018[S42]
				10.0	0.8	Yanishi, 2017[S43]
				4.5	NR	Abdul Aziz, 2018[S44]
	Gait speed and SPPB	NR	Usual	4.0	0.8	Tanaka, 2017[33]; Kamo, 2018[S45]
			NR	3.0	0.8	Tay, 2018[S27]
	Gait speed, TUG, and one-leg standing	Moving	Fastest	5.0	1.0	Kera, 2017[48]
Retrospective	Gait speed only	Moving	Usual	10.0	0.8	Yuki, 2017[39]
		Static	Usual	6.0	0.8	Lou, 2017[S46]
		NR	Usual	6.0	0.8	Roh, 2017[S47]
	Gait speed and SPPB	Moving	Usual	4.0	NR	Jung 2018[S48]
	SPPB					Makiura, 2016[49]; Kim, 2018[S49]
Prospective cohort	Gait speed only	Moving	Usual	4.0	0.8	Jang, 2018[S50]
		NR	Usual	4.0	0.8	Yang, 2017[S35]; Moon, 2016[S51]
				6.0	0.8	Roh, 2017[S52]
			NR	NR	0.8	Harimoto, 2017[S53]
	Gait speed and SPPB	Moving	Usual	4.0	0.8	Kim, 2018[23]
Randomized controlled trial	Gait speed only	Moving	Usual	5.0	NR	Kim, 2016[S54]
		NR	NR	NR	0.8	Mori, 2018[50]
	Gait speed and SPPB	NR	Usual	6.0	0.8	Shen, 2016[S55]
	SPPB					Jang, 2018[S56]
	Senior Fitness Test					Hong, 2017[S57]

NR, not reported; TUG, timed-up-and-go.

Gait speed test

SNUH 분당서울대학교병원 SEOUL NATIONAL UNIVERSITY BUNDANG HOSPITAL

- 구두 명령 예문 (4m 보행)

1. 안녕하세요, 저는 000님의 보행 속도를 측정할 물리치료사(혹은 개인별 직종) 000 입니다.
2. 앞에 보이는 선을 따라 총 2회 저와 같이 걸어볼 예정입니다.
3. 지팡이나 보행차를 평소에 사용하신다면 사용하셔도 괜찮으나, 보호자나 제가 잡아드리진 않습니다.
4. 속도는 평소 걷는 속도이며, 저랑 한 번 걸어볼까요? / 이 때 끝 지점 위치를 숙지시키고 속도를 유지시킴
5. 불편하거나 불안하신 점이 있을까요?
6. 자 이제 여기 시작점에 서서 제가 "준비, 시작" 이라고 하면 출발하세요.
7. "준비, 시작"
8. 잘 하셨습니다. 다시 한 번 해보겠습니다. "준비, 시작"
9. 잘 하셨습니다. 보행 속도 검사가 종료되었습니다.
10. 바로 다음 검사를 시작할까요? 잠시 앉아서 쉬었다가 갈까요? (결과는 2회 중 빠른 값으로)

Gait speed test

SNUH 분당서울대학교병원 SEOUL NATIONAL UNIVERSITY BUNDANG HOSPITAL

- 실습 참고치 (한국 자료 & NIH 자료)

Table 4
Descriptive statistics on the spatial and temporal variables for walking on flat ground (non-standardized data) and independent sample t-tests between gender and age groups.

Valuable		Limbs	older male(n = 47) Mean	SD	older female(n = 42) Mean	SD	young male(n = 15) Mean	SD	young female(n = 16) Mean	SD
Temporal Parameters	Step time (s)	Right	0.530+	0.040	0.525	0.053	0.499	0.028	0.509	0.021
		Left	0.526+	0.040	0.526	0.055	0.500	0.028	0.514	0.020
	Stride time (s)	Right	1.527+	0.247	1.484++	0.214	1.348	0.084	1.361	0.097
		Left	1.504+	0.175	1.509++	0.251	1.329	0.125	1.353	0.066
	Single-support time (s)	Right	0.538	0.095	0.531	0.086	0.509	0.044	0.517	0.040
		Left	0.529+	0.082	0.533	0.093	0.493	0.049	0.507	0.026
		Mean	0.534+	0.041	-	-	0.501	0.026	-	-
	Initial double-support time (s)	Right	0.239+	0.093	0.237++	0.112	0.165	0.045	0.161	0.030
		Left	0.221+	0.068	0.219++	0.071	0.164	0.050	0.162	0.017
	Terminal double-support time (s)	Right	0.221+	0.075	0.213++	0.062	0.173	0.036	0.174	0.029
		Left	0.228+	0.067	0.229++	0.083	0.172	0.043	0.171	0.033
	Support time (s)	Right	0.998+	0.223	0.980++	0.232	0.847	0.069	0.852	0.084
		Left	0.978+	0.153	0.981++	0.204	0.829	0.111	0.839	0.053
	Swing time (s)	Right	0.530+	0.040	0.528	0.055	0.499	0.028	0.509	0.021
		Left	0.526+	0.040	0.528	0.057	0.500	0.028	0.514	0.020
	Cadence (step/min)	Right	113.891+	8.550	114.897	12.256	120.429	6.621	118.112	4.886
		Left	114.658+	8.790	114.755	12.353	120.242	6.621	116.888	4.555
	Walking speed (cm/s)	Right	107.434	18.826	99.306	20.031	140.245	16.657	126.778	13.005
		Left	108.676	19.622	99.114	19.826	140.863	16.747	126.379	13.072
		Mean	[illegible]	[illegible]	[illegible]	[illegible]				
Gait Cycle Ratio Parameters	Single-support time ratio (% gait cycle)	Right	35.242+	3.003	35.409++	2.975	37.814	2.602	38.013	1.262
		Left	35.265+	4.215	35.474++	3.410	37.131	1.759	37.489	1.885
	Initial double-support time ratio (% gait cycle)	Right	15.224+	3.624	15.141++	3.880	12.189	2.705	11.737	1.500
		Left	14.489+	3.166	14.205++	2.524	12.133	2.650	11.938	0.934
	Terminal double-support time ratio (% gait cycle)	Right	14.269	3.600	13.976	2.591	12.867	2.626	12.761	1.518
		Left	15.004	3.509	14.911++	3.864	12.923	2.925	12.559	1.948
		Mean	-	-	14.444++	2.608	-	-	12.660	1.063
	Support time ratio (% gait cycle)	Right	64.735+	4.215	64.526++	3.409	62.869	1.759	62.511	1.885
		Left	64.758+	3.003	64.591++	2.975	62.186	2.602	61.987	1.262
	Swing time ratio (% gait cycle)	Right	35.265+	4.215	35.474++	3.409	37.131	1.759	37.489	1.885
		Left	35.242+	3.003	35.409++	2.975	37.814	2.602	38.013	1.262
spatial Parameters	Step length (cm)	Right	56.458*+	11.802	49.693++	10.230	68.129	9.898	64.309	6.448
		Left	57.446+	11.249	53.347++	10.684	70.503	10.804	64.388	6.132
		Mean	56.952+	8.870	51.520	6.639	-	-	-	-
	Stride length (cm)	Right	113.946*+	17.420	103.122++	12.849	139.040	11.582	127.799	12.901
		Left	113.907*+	18.226	103.167++	13.064	140.103	12.008	129.051	11.640
	Step width(cm)		11.987+	3.129	9.527	3.296	12.017	1.687	8.973	2.651

Mean: Mean value calculated when there are statistical differences for only one leg.
* : < 0.05 between older men and women.
+ : < 0.05 between men in their 65+ and 20 s.
++ : < 0.05 between women in their 65+ and 20 s.

(나이기준 65세;Roh and Kim., 2021)

Table 1 Summary of demographic

Strata Sex (age group [y]), n	Age, y Mean ± SD	Usual Gait Speed Mean ± SD, 95% CI	Maximum Gait Speed Mean ± SD, 95% CI
Men (18-29), 80	23.9±3.6	1.18±0.20, 1.13-1.22	1.85±0.31, 1.78-1.92
Men (30-39), 76	34.9±3.0	1.21±0.21, 1.16-1.26	1.75±0.30, 1.68-1.82
Men (40-49), 87	44.0±2.9	1.21±0.24, 1.16-1.26	1.75±0.44, 1.66-1.85
Men (50-59), 74	53.7±2.6	1.16±0.20, 1.12-1.21	1.63±0.30, 1.56-1.70
Men (60-69), 62	64.2±2.8	1.16±0.22, 1.10-1.22	1.67±0.37, 1.57-1.76
Men (70-79), 61	73.8±2.9	1.07±0.24, 1.01-1.14	1.57±0.42, 1.47-1.68
Men (80-85), 40	81.8±1.8	0.97±0.20, 0.90-1.03	1.39±0.33, 1.29-1.50
Women (18-29), 179	25.4±3.0	1.11±0.20, 1.09-1.14	1.57±0.29, 1.52-1.61
Women (30-39), 223	34.2±2.9	1.15±0.20, 1.12-1.18	1.66±0.35, 1.61-1.71
Women (40-49), 153	43.9±2.9	1.14±0.23, 1.10-1.18	1.64±0.35, 1.58-1.69
Women (50-59), 100	53.6±2.7	1.15±0.22, 1.10-1.19	1.60±0.29, 1.54-1.65
Women (60-69), 82	63.7±2.7	1.05±0.22, 1.04-1.02	1.51±0.43, 1.41-1.60
Women (70-79), 61	73.2±2.7	0.99±0.22, 0.94-1.05	1.29±0.28, 1.22-1.36
Women (80-85), 42	81.9±1.5	0.95±0.24, 0.88-1.02	1.28±0.24, 1.20-1.35

Abbreviation: CI, confidence interval.

(Bohannon and Wang., 2019)

Chair stand test

SNUH 분당서울대학교병원 SEOUL NATIONAL UNIVERSITY BUNDANG HOSPITAL

- 검사에 필요한 요소
  - 구두 지시문, 시범, 10초 간의 연습, 표준 의자 :
    - 등받이, 시트 높이 45cm, 팔 걸이 높이 : 65cm
  - 1회의 정의 : 명확하게!
    - 시작 = 앉은 자세
    - 끝 = 앉은 자세 혹은 선 자세
  - 대상자의 자세 : 양 발은 바닥에, 양 팔은 팔짱
  - 의자를 고정해주세요.
  - 최대한 빠른 속도로

Table 1. Clinical and Demographics Descriptive Statistics.

	Sufficiently Active (n = 50)	Insufficiently Active (n = 31)	p-values	Total
Age (years)	25.1 ± 3.3	24.8 ± 3.6	0.720	25.1 ± 3.4
Race, N (percent)	White 39 (78.0) Others 11 (22.0)	White 20 (64.5) Others 11 (35.5)	0.185	White 54 (66.7) Others 27 (33.3)
Sex, N (percent)	Males 16 (32.0) Females 34 (68.0)	Males 18 (58.1) Females 13 (41.9)	NA	Males 34 (42.0) Females 47 (58.0)
Body Mass (kg)	69.3 ± 14.6	77.7 ± 17.3	0.021	72.6 ± 16.1
Body Height (m)	1.7 ± 0.1	1.7 ± 0.9	0.122	1.7 ± 0.1
BMI (kg/m²)	24.1 ± 4.3	25.9 ± 4.9	0.086	24.8 ± 4.6
IPAQ Leisure Domain (MET-minute/week)	2297.7 ± 1265.6	444.2 ± 325.1	<0.001	1588.3 ± 1357.4
30-CST (Repetitions)	34.0 ± 5.2	31.5 ± 5.5	0.040	33.0 ± 5.4
Five Times Sit-to-Stand (Seconds)	4.3 ± 0.6	4.5 ± 0.8	0.223	4.4 ± 0.7
Lateral Step-Down (Repetitions)	18.0 ± 2.1	18.1 ± 2.6	0.760	18.1 ± 2.3
Modified Lateral Step-Down (Repetitions)	15.2 ± 2.4	15.1 ± 3.1	0.881	15.2 ± 2.6

BMI: Body Mass Index; IPAQ: International Physical Activity Questionnaire; MET: Metabolic Equivalent of Tasks; 30-CST: 30-Second Chair-Stand Test.
Values are represented as means ± SD.

(Lein et al., 2022)

Chair stand test

SNUH 분당서울대학교병원 SEOUL NATIONAL UNIVERSITY BUNDANG HOSPITAL

- End with sit or stand?
  - 많은 문헌에서 끝자세를 명확히 표기하지 않음
  - 선 자세로 끝냈을 때와 앉은 자세로 끝냈을 때 기준 시간이 다름
  - **중요한 건 일관성!**

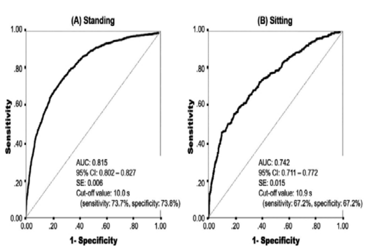


Figure 1 Receiver operating characteristic curves for the SCS corresponding to a gait speed <1.0 m/s (ending with the standing position A and the sitting position B). The cut-off values corresponding to a gait speed <1 m/s were 10.0 s and 10.9 s for A and B, respectively. AUC, area under the curve; 95% CI, 95% confidence interval; SE, standard error.

(Yamada et al., 2021)

Chair stand test

SNUH 분당서울대학교병원 SEOUL NATIONAL UNIVERSITY BUNDANG HOSPITAL

- 구두 명령 예문 (5회 앉고 서기)

1. 안녕하세요, 저는 000님의 신체 수행 능력을 측정할 물리치료사(혹은 개인별 직종) 000 입니다.
2. 의자에서 앉았다 일어서기를 5회 해볼 예정이며, 섰다가 앉는 것이 1회입니다.
3. 의자 가운데 앉으시고 양 발은 바닥에 닿아야 하고, 양 팔은 가슴 앞에서 팔짱 끼세요.
4. 한 번 연습해보겠습니다. 준비 시작
5. 잘 하셨습니다. 지금처럼 검사의 끝은 반드시 앉은 자세입니다.
6. 자 이제 검사를 시작하겠습니다. 연습해본 것 처럼 앉고 서기를 최대한 빠르게 5회 하겠습니다.
7. "준비, 시작" / 이 때 검사자는 큰 소리로 개수를 센다.
8. 잘 하셨습니다. 검사가 종료되었습니다.
9. 바로 다음 검사를 시작할까요? 어지럽지 않으세요?

Chair stand test

SNUH 분당서울대학교병원

• 참고치

TABLE 1 | Age-specific and sex-specific percentile of CS-5 time [in sec] in men and women (n = 12,603).

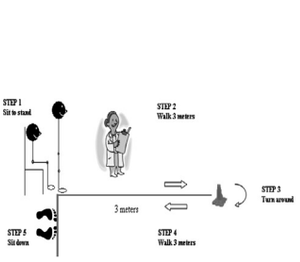
Sex/age group	n	Mean (sec)	SD (sec)	P5 (sec)	P25 (sec)	P50 (sec)	P75 (sec)	P95 (sec)
Men (n = 5,964)								
40–44	37	8.76	3.40	5.12	7.19	7.93	9.19	19.94
45–49	1,070	8.91	2.77	5.25	6.97	8.40	10.30	14.25
50–54	911	9.36	2.79	5.57	7.21	8.84	11.12	14.58
55–59	1,228	9.86	3.14	5.62	7.66	9.34	11.64	15.66
60–64	1,092	10.23	3.13	6.12	8.04	9.73	11.73	16.44
65–69	725	10.81	3.19	6.25	8.35	10.07	12.34	16.78
70–74	604	11.75	3.58	7.03	9.17	11.00	13.83	18.51
75–79	281	12.52	4.05	6.84	9.62	11.75	14.93	19.94
80+	116	14.06	4.08	7.68	11.19	13.54	16.59	22.66
Women (n = 6,641)								
40–44	241	9.43	2.95	5.62	7.51	8.94	11.06	14.91
45–49	1,473	9.94	2.88	5.90	7.75	9.38	11.44	15.29
50–54	1,031	10.46	3.17	6.06	8.15	10.03	12.30	16.35
55–59	1,291	10.91	3.33	6.28	8.53	10.35	12.72	17.12
60–64	1,053	11.36	3.44	6.67	8.88	10.78	13.22	18.28
65–69	674	12.11	3.67	6.97	9.50	11.66	14.13	19.31
70–74	390	12.82	4.04	7.44	9.78	12.23	15.31	20.54
75–79	259	13.46	3.96	7.82	10.50	13.00	15.97	20.83
80+	129	14.89	4.60	7.07	11.38	14.60	18.22	22.75

CS-5, 5-repetition chair stand test; P, percentile; SD, standard deviation.

(Gao et al., 2021

Timed-up and go

SNUH 분당서울대학교병원



https://strokengine.ca/en/assessments/timed-up-and-go-tug/

Timed-up and go

SNUH 분당서울대학교병원

• 구두 명령 예문 (Timed up and go)

1. 안녕하세요, 저는 000님의 신체 수행 능력을 측정할 물리치료사(혹은 개인별 직종) 000 입니다.
2. 의자에 앉은 상태에서 일어나 앞에 보이는 콘을 돌아 다시 의자에 앉는 시간을 측정하겠습니다.
3. 양 발을 선 바로 앞에 "나란히" 놓고 의자에 앉아주세요.
4. 한 번 연습해보겠습니다. 준비 시작! (일어나세요, 콘까지 걸어 보세요, 콘을 돌게요, 다시 의자까지 걸어보세요, 앉으세요)
5. 잘 하셨습니다. 지금처럼 검사의 끝은 반드시 앉은 자세입니다.
6. 자 이제 검사를 시작하겠습니다. 평소 걷는 속도로 해주세요.
7. "준비, 시작" / 이 때 검사자는 함께 걷는다.
8. 잘 하셨습니다. 검사가 종료되었습니다.
9. 바로 다음 검사를 시작할까요? 어지럽지 않으세요?

Gait speed test (400m)

SNUH 분당서울대학교병원

• Long distance test 트랙의 예시

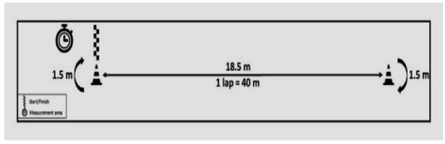


Fig. 1 ◂ Start/finish at the left cone

- 특별한 가속/감속 구간이 없다.
- 회전 구간을 고려하면 20m 이상의 직선 공간이 필요하다.

(Lindermann et al., 2021)

Gait speed test (400m)

SNUH 분당서울대학교병원

• 구두 명령 예문 (400m 보행)

1. 안녕하세요, 저는 000님의 보행 지구력을 평가할 물리치료사(혹은 개인별 직종) 000 입니다.
2. 저랑 같이 400m를 걸어보겠습니다. 앞에 보이는 선을 따라 10바퀴를 걷겠습니다.
3. 속도는 편한 속도로 걷다가, 중간 부터 힘드시다면 느리게 걸어도 괜찮습니다.
4. 걷는 중에 더 이상 걷기 힘들 때에는 말씀해주세요.
5. 이제 시작해보겠습니다. 제가 옆에서 같이 걷겠습니다.
6. 잘 하셨습니다. 검사가 종료되었습니다.
7. 어지럽지 않으세요?

Take-home message

SNUH 분당서울대학교병원

• HGS + SPPB를 기본 평가로 실시한다.

• KWGS의 권고에 따라, 신체 기능 평가를 1-2가지 더 수행한다.

  • (TUG, 30s CST, 혹은 400m walking)

• 각 검사 평가자에 대한 사전 훈련이 필요하며, 검사의 신뢰도를 높이기 위해 표준화된 지침을 문서화하여 따른다.

• 검사에 소요되는 장비와 공간을 주기적으로 관리한다.

• 측정 간 모호한 부분은 기록한다.

Take-home message

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- Hand grip strength
  - 장비 확인: 장비에 따른 자세가 다르다.
  - 사용 전 악력계의 두께를 대상자에 맞게 조절한다.
  - 충분한 설명과 연습 제공, 최대 수행 >> 제한된 시간의 수행
- SPPB
  - 균형 검사 (반)일렬 자세를 할 때 앞으로 나오는 발은 대상자가 앞에 두어도 편한 발로 한다.
  - 연습 동안 편한 발을 확인한다.
- 보행 속도 검사 (short, long)
  - 코스를 마련해 둘 것 (가속/감속 구간 확보, 장애물 없는 공간, 일정한 공간)
  - 시작과 끝을 명확히 할 것, 가능하다면 자동화된 장비를 사용
- 의자에서 앉고 서기 (TUG 포함)
  - 의자 선택, 자세 중요!
  - 1회의 정의를 반드시 명확하게 하고, 일관성 있게 한다.

참고자료

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2023년 대한근감소증학회 제15차 학술대회 강의록

인 쇄 일 2023년 11월 14일

발 행 일 2023년 11월 18일

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