eman ta zabal zazu

Medikuntza eta Erizaintza Fakultatea
Fisiologia Saila

Universidad del País Vasco
Euskal Herriko Unibertsitatea

Luzera desberdineko ariketa fisikoko esku-hartzeen eragina ospitalizazio bat pairatu duten adinekoen funtzio fisiko, egoera nutrizional, bizi-kalitate, hauskortasun eta sarkopenian

Effect of different-lengths physical exercise interventions on physical function, nutritional status, quality of life, frailty, and sarcopenia in post-hospitalized older adults

2021

Doktorego Tesia **Iñaki Echeverria Garay**

Zuzendariak **Jon Irazusta Astiazaran** **Isabelle Bourdel-Marchasson**

Luzera desberdineko ariketa fisikoko esku-hartzeen eragina ospitalizazio bat pairatu duten adinekoen funtzio fisiko, egoera nutrizional, bizi-kalitate, hauskortasun eta sarkopenian.

Effect of different-lengths physical exercise interventions on physical function, nutritional status, quality of life, frailty, and sarcopenia in post-hospitalized older adults.

Doktorego Tesia

Iñaki Echeverria Garay

Zuzendariak

Jon Irazusta Astiazaran

Isabelle Bourdel-Marchasson

2021

ESKER ONAK

ACKNOWLEDGEMENTS

ESKER ONAK / ACKNOWLEDGEMENTS

Uzten badidazue lehenik nire tesiaren egona azaltzen duen etxeko pasarte bat idatziko dut: *Aitak Semeari:* Noiz bukatukozu ikasten?

Semeak Aitari: Espeo inoiz ez. Ikastea beti ongi dator eta.

Amaren ahotsa entzuten da: Bueno, bakizu ze esan nahi duen. Erantzuiozu ongi.

Semeak: Zuek lasai nik baino gogo gehio ez ditula inork. Bukatzean abisatuko dizuet, eon lasai.

Hitz gutxiko pertsona izan arren atal honetan eskerrak ematea gustatuko litzaidake. Proiektu luze, gogor baina aberasgarri honetan, zorionez, pertsona berri asko ezagutzeko parada izateaz gain, aurrez ezagun nituen beste batzuk ondoan izatearen pribilegioa sakontzeko balio izan dit.

Esker mila Euskal Herriko eta Bordeleko Unibertsitateei emandako laguntza ekonomikoagatik eta, honekin batera, EHU-ko Medikuntza eta Erizaintza Fakultateko Fisiologia Sailari, UB-ko Science de la vie et de la santé doktorego eskolari eta Arabako Santiago Ospitale Unibertsitateari tesia egiteko baimena emateagatik.

Mila esker zuri Jon Irazusta, Tesiko zuzendari eta bidelagun izateagatik. Momentu txar eta onak bizi izan ditugu elkarrekin, baina benetan asko eskertzen dizut gauza guztietarako erantzun bat izateko egin duzun esfortzuagatik. Bide honetan ikasi dudana nagusiki zuri zor dizut. Berriz ere eskerrik asko Jon!

Bien sûr, merci aussi à toi, Isabelle Bourdel-Marchasson, pour toute ton aide pendant la thèse et pour le soutien et les facilités fournies pendant mon séjour à Bordeaux. Ce fut une grande expérience de travailler avec toi et d'apprendre de toi. Esker mila Ixabel!

Neurketa eta esku-hartzeetan lagundutako guztiei ere eskerrik asko, zuen laguntza ezinbestekoa izan baita proiektu hau aurrera eramateko. Mila esker Maria Amasene, Miriam Urquiza, Ane Errasti, Garbiñe Lozano, Julen Gomez, Cristina Alonso, Nekane Nograro, Guillermo Cano, Cristina Bernad eta ospitalean erreferente nuen Ariadna Besga.

Mila esker ere Ageing On Ikerketa Taldeari, proiektuan emandako laguntza guztiagatik eta lehenengo egunetik harrera bikaina egiteagatik! Eskerrik asko Ana Rodriguez, Begoña Sanz, Susana Gil, Javi Gil, Jon Torres, Fatima Ruiz, Maider Kortaxarena, Idoia Zarrazkin, Izaro Esain, Iraia Bidaurrazaga, Iratxe Duñabeitia, Gotzone Hervás eta abar luze bat. Asko gara eta!

Merci également au Centre de Résonance Magnétique des Systèmes Biologiques (RMSB, rattaché au CNRS et à l'Université de Bordeaux), à son directeur et, bien sûr, à mes collègues pour toutes les facilités mises à ma disposition. J'ai pu me familiariser et travailler dans un nouveau domaine de recherche.

Ezin zaituztet aipatu gabe utzi Chloe eta Haritz, tesiko bide luze honetan zein nire ikerlari bide labur honen hasieran beti hor egon zaretelako. Plazer hutsa izan da bai aurretiaz beste proiektuetan zuek biokin lan egitea eta baita ere, egun, nire tesiko oztopoetan zuen laguntza izatea! Animo zeuen bideetan eta esker beroenak!

Esker mila ere kuadrilakoei, egon ezin eta tentsioak ahazteko ezinbestekoak izan zarete emandako poztasun une eta eta animo guztiekin. Eskerrik asko Arregi, Balen, Goiko, Itur, Mc, Murzk, Peruya, Ruba eta Sora!

Nola ez, nire miresmen eta esker ona zuei, Ama (Maria) eta Aita (Inaxio). Ez bakarrik beti hor egoteagatik, baizik eta horrelako erronka baten aurrean zuen babesik gabe ez nukeelako lortuko, baita ere, horrelako erronka bati aurre egiteko tresnak eta indarrak eskeini dizkidazuelako.

Bukatzeko, zu zatoz, Mof, alegia, zeu Ana. Nire bidea gertutik eta barnetik bizi izan duzu eta horregatik ez daukat hitzik niregatik egin duzun guztia eskertzeko. Zu izan zara momentu txarrenetan amore ez ematearen arduradun nagusia eta horrexegatik, benetan, asko eskertzen dizut izan duzun pazientzia eta ni ulertzeko gaitasuna. A ze merezitako lasaitua hartuko duzun proiektu honi amaiera ematen diodanean, baina hoberena ez da hori, baizik eta badakidala etorkizunean etortzen diren beste hainbat proiektuetan ere, zeu, bertan egongo zarela eta horrek asko lasaitzen nau.

Emandako laguntza, indar eta oreka guztiagatik, bihotz-bihotzez, mila esker guztioi!

Ama, Aita eta Mofi zuengatik

AURKIBIDEA

INDEX

AURKIBIDEA / INDEX

LABURPENA

ABSTRACT

RÉSUMÉ

LABURPENA / ABSTRACT / RÉSUMÉ

LABURPENA

Aurrekari nagusiak eta helburuak

Zahartzen joan hala benetako erronka autonomia mantentzea da eta hori da, hain zuzen ere, zahartze aktiboaren helburu nagusietariko bat. Epe ertaineko proiekzioek agerian uzten dute gizartearen desgaitasun eta mendekotasun tasen gorakada, eta horrekin batera iraupen luzeko zainketa beharrak ere. Ospitaleraturiko zein ospitalizazio bat pairatu berri duten helduek populazio zaurgarri konplexu eta heterogeneoa osatzen dute; komunitatean bizi diren adineko pertsonekin alderatuta urritasun fisiko, nutrizional eta kognitibo eta hauskortasun, bizi-kalitate galera eta sarkopenia intzidentzia handiagoak dituztenak. Zentzu honetan, azken urteetan adineko pertsonen funtzionaltasun galerari aurre egiteko esku-hartzeen inguruko azterlanen kopurua esponentzialki handitu da eta ebidentzia-maila altuena erakutsi duten esku-hartzeen artean ariketa fisikoan oinarritutakoak ditugu. Hala ere, gaiari buruzko inguruko ikerketa gehienak komunitatean bizi diren pertsonengan gauzatu dira, eta orain arte ez da ondorioztatu hirugarren adineko pertsonentzako egoera akutu baten ondoren errekuperatu ahal izateko zein ariketa fisiko mota den egokiena. Hortaz, ikerketa proiektu honen helburu nagusia, ospitaleratu ondoren helduengan iraupen desberdineko taldeetan oinarrituta, osagai anitzeko bi esku-hartzeren eraginkortasuna aztertzea izan da.

Material eta metodoak

Parte-hartzaileak Arabako Unibertsitate Ospitaleko (HUA) Barne Medikuntza eta Neurologia zerbitzuetan errekrutatu ziren. Parte-hartzaile hautagarriek hurrengo irizpideak betetzen zituzten: ≥ 70 urte, ≥ 20 puntu Mini Mental State Examination eskalan, eta gutxienez (laguntza-gailuekin edo gabe) 4 metro modu independentean ibiltzeko gai ziren. Parte-hartzaile guztiek baimen informatua sinatu zuten eta ausaz epe motzeko adar (EMA) edo epe luzeko adar batera (ELA) esleitu zitzaien. Bioaraba Osasun Ikerketa Institutuko Entsegu Kliniko eta Etika Batzordeak (CEIC-HUA Code Expte. 2017-021) eta Euskal Herriko Unibertsitateko Agente Biologikoen eta genetikoki eraldatutako organismoen Ikerketetarako Etika Batzordeak ere (ABIEB M30/2018/201) ikerlana onartu zuten. Ikerketa proiektuaren protokoloa berriz Australian and New Zealand Clinical Trials Registry-n (ANZCTR) erregistratu zen honako kodea eskuratuz: ACTRN12619000093189.

Emaitzak

Doktorego tesi honen emaitzen atala, ikerketa-proiektutik eratorritako lau artikulutan aurkeztuko da. Lehen biak eta azken artikulua argitaratuak daude, eta hirugarrena berriz

berrikuspen prozesuan dago.

*1. artikulua:*Lehenengo artikulu horretan, ospitaleratu ondoko adineko pazienteek ariketa fisikoa baztertzea laguntzen duten faktoreak identifikatzea proposatu genuen. Aztertutako pazienteen artean, gehienek (% 88,8k) ez zuten parte hartu ariketa fisikoaren programan. Aldagai anitzeko erregresioak agerian utzi zuen adin handia, nutrizio-egoera txarra eta etxerako irisgarritasun txikiagoa zirela parte-hartzea baztertzeko faktore prediktiboak. Gainera, parte hartzeari uko egin zioten pazienteek Short Physical Performance Battery eskalan eta haien oreka, hanken indar eta ibilera abiadura probetan errendimendu eskasagoa zuten. Taldeen artean beste aldagai batzuetan ez da desberdintasunik aurkitu.

2. artikulua: Bigarren artikuluan, ospitaleratu ondoren helduen funtzio eta jarduera fisiko, bizi-kalitate, antropometria eta nutrizio-egoerari dagokienez taldean eta etxean egindako epeen iraupen desberdinekin egindako osagai anitzeko ariketa fisikoko bi esku-hartzeren onurak alderatu ziren. Funtzio fisikoa, jarduera fisikoa, bizi-kalitatea, antropometria eta nutrizio-egoera hasieran, 12 asteren ondoren eta 24 asteren ondoren ebaluatu ziren. Ospitale-altari aplikatutako osagai anitzeko ariketa fisikoko bi esku-hartzeek 12 asteren ondoren funtzio fisiko eta nutrizio-egoeran onura nabarmenak ekarri, eta jarduera fisikoa handitu zuten, eta hurrengo 12 asteetan ondorio positiboei eutsi zieten. Aztertutako aldagaietan ez zen talde-denbora elkarrekintzarik hauteman.

3. artikulua: Hirugarren artikuluan, hauskortasun eta sarkopenian osagai anitzeko ariketa fisikoko eta gainbegiratutako talde-saioko epe iraupen desberdineko bi esku-hartzeren ondorioak aztertu eta alderatu ziren. Hauskortasun-egoera eta sarkopenia hasieran eta 3 hilabetera, Fried-en indizearekin eta EWGSOP-en berrikusitako gorte-puntuekin ebaluatu ziren. Taldeen barruko aldaketei dagokienez, 3 hilabeteko esku-hartzearen ondoren, bi taldeek Fried-en indizea murriztu zuten. Sarkopenia egiaztatua zuten pazienteen ehunekoak bi taldeetan ere hobera egin zuen, baina ez zen eragin esanguratsurik izan. Ez zen talde-denbora interakziorik hauteman.

4. artikulua: Laugarren eta azken artikuluan, ospitaleratu ondoko adineko pertsonetan miostatinaren eta follistatinaren eta hauskortasuna eta/edo sarkopenia arteko lotura alderatzea proposatu genuen. Gainera, bi miokinek hauskortasuna eta sarkopenia identifikatzeko duten gaitasuna proba fisikoek dutenekin alderatu zen. Hauskortasuna edo sarkopenia duten pertsonetan miostatina-kontzentrazioa txikiagoa izan zen, eta follistatinina-kontzentrazioa berriz, handiagoa. Hartzailearen ezaugarri operatiboen kurbek (ROC) erakutsi zuten ibilera abiadura eta altxa, ibili, bira eta eseri (8TUG) probak

hauskortasuna identifikatzeko gaitasun handiagoa zutela. Miostatina izan zen sarkopenia identifikatzeko gai zen aldagai bakarra.

Ondorioak

Ikerketa honek ospitalizazioaren ondoko ariketa fisikoko programa batean pertsona helduek parte-hartze txikia dutela berretsi egin du. Izandako emaitzen bidez, ospitaleratu ondoren helduen irisgarritasuna hobetzeko eta ariketa fisikoko programetan parte-hartzea areagotzeko estrategien berri eman da. Bereziki parte hartzeko joera txikiena duten biztanlerian ariketa fisikoko programetan parte hartzeko ahalegin handiak egin behar dira.

Osagai anitzeko bi esku-hartzeek funtzio fisikoa eta nutrizio-egoera hobetu zituztela kontuan hartuta, zehaztu zen hogeita lau astera arte etxean jarraitzen dutenean sei asteko talde saio ariketako esku-hartzea baten onura funtzional eta nutrizionalak, hamabi asteko talde saio baten antzekoak sortzen zirela. Emaitza horiek informazio baliotsua ematen dute adinekoek ospitaleratu ondoren egin beharreko ariketa fisiko interbentzio praktiko, egingarri eta errentagarriak diseinatzeko.

Bestalde, hauskortasunean nahiz eta osagai anitzeko bi esku-hartzeek antzeko edo ia onurak berdinak eragin, sarkopeniarekin ez zen gauza bera gertatu. Hori dela eta, zehaztu zen osagai anitzeko ariketa fisikoko 6 asteko talde saioak nahikoak direla hauskortasuna aldatzeko. Sarkopeniaren tratamenduaren eta prebentzioaren eragina argitzeko berriz lagin handiagoko azterketa gehiago justifikatzen dira.

Miostatina ospitaleratu ondoko adineko helduentan sarkopenia identifikatzeko biomarkatzaile erabilgarria izan daiteke. Haatik, folistatina eta miostatinak hauskortasuna identifikatzeko gaitasun txikiagoa dute proba fisikoek baino. Lagin handiagoak eta miokina horiek beste biomarkatzaile batzuekin batera erabiliz azterketa gehiago egitea justifikatzen da.

Aurretik adierazitakoaren argitan, ospitaleratu ondoren helduen ariketa fisikoko programetara irisgarritasuna hobetzeko eta parte hartzea handitzeko estrategiak erakutsi ditugu. Era berean, izandako emaitzak eta esku-hartzeei lotutako ondorio negatiborik egon ez dela, tolerantzia ona egon dela eta bertaratze tasa handiak egon direla kontuan hartuta, berretsi behar da informazio baliotsua eman dela pertsona helduetan ospitaleratu ondoren egin beharreko ariketa fisikoko interbentzio praktiko, egingarri eta errentagarriak diseinatzeko.

ABSTRACT

Background and objectives

One of the challenges of aging is to maintain independence as we age, and this is, in particular, one of the main objectives of active aging. Medium-term projections show an increase in disability and dependency rates in society and, therefore, in long-term care needs. Older adults who are hospitalized or have undergone recent hospitalization represent a complex and heterogeneous vulnerable population, with physical, nutritional and cognitive impairments, along with a higher incidence of frailty, loss of quality of life and sarcopenia than those without an hospitalization history. In this regard, in recent years there has been an exponential increase in the number of studies on interventions to address the loss of functionality in the elderly. Among the interventions that have shown the highest level of evidence are those involving physical exercise. However, most of the research on the subject has been conducted on people living in the community and so far, no conclusion has been reached as to which type and duration of physical exercise is the most suitable for recovery after an acute situation. Therefore, the main objective of this research project was to analyze the efficacy of two multicomponent exercise interventions based on groups of different duration in older adults after hospitalization.

Materials and methods

Participants were recruited from the Internal Medicine and Neurology services of the University Hospital of Araba (HUA). Eligible participants were aged ≥70 years, scored ≥20 on the Mini Mental State Examination, and were able to walk (with or without assistive devices) independently for at least 4 m. All participants provided informed consent and were randomly assigned to either a short-term group-based branch (SGB) or a long-term group-based branch (LGB). The study was approved by the Committee on Ethics in Research at the University Hospital of Araba (CEIC-HUA Code Expte. 2017-021). The Biological Agents Committee of the University of the Basque Country (CEIAB M30/2018/201) also approved the study. The protocol was registered under the Australian and New Zealand Clinical Trials Registry (ANZCTR) with the identifier ACTRN12619000093189.

Results

The results section in this doctoral thesis will be presented in the form of four articles derived from the research project. The first two and the last article have already been published, while the third is under review.

Article 1: In this first article, we aimed to identify factors that contribute to exercise intervention refusal among post-hospitalized older patients. Among the analyzed

patients, the vast majority (88.8%) declined participation in the physical exercise program. Multivariate regression revealed that older age, poor nutritional status, and reduced home accessibility were predictors of participation refusal. Moreover, patients who declined participation had worse performance on the Short Physical Performance Battery and on their tests of balance, leg strength, and walking speed. No differences were found between groups in other variables.

Article 2: In the second article we compared the benefits of two multicomponent physical exercise interventions with different group- and home-based period lengths on physical function, physical activity, quality of life, anthropometry, and nutritional status among older adults after hospitalization. Physical function, physical activity, quality of life, anthropometrics, and nutritional status were assessed at baseline, after 12 weeks, and after 24 weeks of intervention. Both multicomponent physical exercise interventions implemented at hospital discharge provided significant benefits in physical function and nutritional status and increased physical activity after 12 weeks of intervention and maintained the positive effects during the following 12 weeks. No group-by-time interaction was observed in any of the studied variables.

Article 3: In the third article, we analyzed and compared the effects of two multicomponent physical exercise interventions with different supervised group-based period lengths on frailty and sarcopenia. Frailty status and sarcopenia were assessed at baseline and at 3 months with Fried´s Index and revised EWGSOP cut-off points. Regarding changes within groups, both groups reduced Fried's Index after 3-month intervention. Percentage of patients with confirmed sarcopenia tended to improve in both interventions, but we were not able to observe change in sarcopenia. No group-by-time interaction was observed.

Article 4: In the fourth and the last article we aimed to compare the association between myostatin and follistatin and frailty and/or sarcopenia in post-hospitalised older people. In addition, the capability of both myokines for identifying frailty and sarcopenia was compared with physical tests. Myostatin concentration was lower and follistatin concentration higher in people with frailty or sarcopenia. Receiver operating characteristic curves indicated that gait speed and 8-Foot Timed Up and Go Test had the greatest capability for identifying frailty. Myostatin was the only biomarker capable of identifying sarcopenia.

Conclusions

This study confirms low participation of older adults in a post-hospitalization physical exercise program. These findings inform strategies to improve accessibility and increase older adult participation in physical exercise programs following hospitalization. Efforts

are needed to increase participation in physical exercise programs, specifically in populations that are less prone to participate.

Considering that both the multicomponent interventions improved physical function and nutritional status, we determined that six weeks of a group-based exercise intervention caused similar functional and nutritional benefits to a longer group-based intervention of twelve weeks when both are continued at home until twenty-four weeks. These results provide valuable information for the design of practical, feasible, and cost-effective physical exercise interventions following hospitalization in older adults.

On the other hand, although both multicomponent interventions caused similar or nearly equal benefits in frailty, the same was not true for sarcopenia. Therefore, we determined that a 6-week multicomponent group-based exercise intervention is sufficient to reverse frailty. Further studies with larger samples are warranted to clarify the effect of treatment and prevention of sarcopenia.

Myostatin may be a useful biomarker for sarcopenia in post-hospitalised older adults. Nevertheless, myostatin and follistatin have a lower capability for identifying frailty than physical tests. Further studies using larger samples and these myokines together with other biomarkers are warranted.

In light of the above, we have shown strategies to improve accessibility and increase older adult participation in physical exercise programs following hospitalization. Likewise, taking into account these results along with the absence of negative effects associated with the interventions, the good tolerance and overall high attendance rates observed, these results provide valuable information for the design of practical, feasible, and cost-efective physical exercise interventions following hospitalization in older adults.

RÉSUMÉ

Contexte et objectifs

L'un des défis du vieillissement est de maintenir l'indépendance au fur et à mesure que l'on vieillit, et c'est notamment l'un des principaux objectifs du vieillissement actif. Les projections à moyen terme montrent une augmentation des taux d'invalidité et de dépendance dans la société et, par conséquent, des besoins en soins de longue durée. Les personnes âgées hospitalisées ou ayant subi une hospitalisation récente représentent une population vulnérable complexe et hétérogène, présentant des déficiences physiques, nutritionnelles et cognitives, ainsi qu'une incidence plus élevée de fragilité, de perte de qualité de vie et de sarcopénie que les personnes vivant dans la communauté. À cet égard, ces dernières années, on a assisté à une augmentation exponentielle du nombre d'études sur les interventions visant à remédier à la perte de fonctionnalité des personnes âgées. Parmi les interventions qui ont montré le plus haut niveau de preuve, on trouve celles impliquant l'exercice physique. Cependant, la plupart des recherches sur le sujet ont été menées sur des personnes vivant dans la communauté (n'ayant pas récemment été hospitalisé ou n'ayant pas subit un problème de santé aigu récent) et, jusqu'à présent, aucune conclusion n'a été tirée quant au programme d'exercice physique le plus adapté à la récupération après une situation aiguë. Par conséquent, l'objectif principal de ce projet de recherche était d'analyser l'efficacité de deux interventions en exercice physique à composantes multiples basées sur des groupes de durée différente chez des personnes âgées après une hospitalisation.

Matériel et méthodes

Les participants ont été recrutés dans les services de médecine interne et de neurologie de l'hôpital universitaire d'Araba (HUA). Les participants éligibles étaient âgés de ≥70 ans, avaient un score ≥20 au Mini Mental State Examination, et étaient capables de marcher (avec ou sans dispositifs d'assistance) de manière indépendante sur au moins 4 m. Tous les participants ont signé un consentement éclairé de participation à l'étude et ont été assignés de manière aléatoire à un bras proposant une intervention en groupe sur une courte période (GCP) ou à à un bras proposant une intervention en groupe sur une longue période (GLP). L'étude a été approuvée par le Comité d'éthique de la recherche de l'hôpital universitaire d'Araba (CEIC-HUA Code Expte. 2017-021). Le Comité Biologie de l'Université du Pays basque (CEIAB M30/2018/201) a également approuvé l'étude. Le protocole a été enregistré dans le registre des essais cliniques australiens et néo-zélandais (ANZCTR) avec l'identifiant ACTRN12619000093189.

Résultats

Le chapitre des résultats de cette thèse de doctorat sera présenté sous la forme de quatre articles dérivés du projet de recherche. Les deux premiers et le dernier article ont déjà été publiés, tandis que le troisième est en cours de révision.

Article 1 : Dans ce premier article, nous avons cherché à identifier les facteurs qui contribuent au refus d'exercice chez les patients âgés après une hospitalisation. Parmi les patients analysés, la grande majorité (88,8%) a refusé de participer au programme d'exercice physique. La régression multivariée a révélé que l'âge avancé, le mauvais état nutritionnel et l'accessibilité réduite du domicile étaient des facteurs prédictifs du refus de participer. En outre, les patients qui ont refusé de participer avaient de moins bons résultats à la Short Physical Performance Battery et aux tests d'équilibre, de force des jambes et de vitesse de marche. Aucune différence n'a été constatée entre les groupes pour les autres variables.

Article 2 : Dans le deuxième article, nous avons comparé les bénéfices de deux interventions d'exercice physique à composantes multiples avec des périodes différentes en groupe et à domicile sur la fonction physique, l'activité physique, la qualité de vie, l'anthropométrie et le statut nutritionnel chez les personnes âgées après une hospitalisation. La fonction physique, l'activité physique, la qualité de vie, l'anthropométrie et l'état nutritionnel ont été évalués au départ, après 12 semaines et après 24 semaines d'intervention. Les deux interventions d'exercice physique à multicomposantes mises en œuvre à la sortie de l'hôpital ont apporté des bénéfices significatifs en termes de fonction physique et d'état nutritionnel et ont augmenté l'activité physique après 12 semaines d'intervention et ont maintenu les effets positifs pendant les 12 semaines suivantes. Aucune interaction groupe-temps n'a été observée dans aucune des variables étudiées.

Article 3 : Dans le troisième article, nous avons analysé et comparé les effets sur la fragilité et la sarcopénie de deux interventions d'exercice physique multicomposantes avec différentes durées de périodes supervisées en groupe. Le statut de fragilité et la sarcopénie ont été évalués au départ et à 3 mois avec l'indice de Fried et les points de coupure révisés de l'EWGSOP. Les deux groupes ont réduit l'indice de Fried après 3 mois d'intervention. Le pourcentage de patients présentant une sarcopénie confirmée a eu tendance à s'améliorer dans les deux groupes, mais il n'y a pas eu d'effet visible significatif sur la sarcopénie. Aucune interaction groupe-temps n'a été observée.

Article 4 : Dans le quatrième et dernier article, nous avons cherché à comparer l'association entre la myostatine et la follistatine et la fragilité et/ou la sarcopénie chez les personnes âgées post-hospitalisées. De plus, la capacité des deux myokines à

identifier la fragilité et la sarcopénie a été comparée à des tests physiques. La concentration de myostatine était plus faible et celle de la follistatine plus élevée chez les personnes fragiles ou sarcopéniques. Les courbes de caractéristiques d'exploitation du récepteur ont indiqué que la vitesse de la marche et le test du lever et du coucher chronométré à 8 pieds étaient les plus aptes à identifier la fragilité. La myostatine était la seule variable capable d'identifier la sarcopénie.

Conclusions

Cette étude confirme la faible participation des adultes âgés à un programme d'exercice physique après une hospitalisation. Ces résultats éclairent les stratégies visant à améliorer l'accessibilité et à accroître la participation des personnes âgées aux programmes d'exercice physique après une hospitalisation. Des efforts sont nécessaires pour augmenter la participation aux programmes d'exercice physique, en particulier dans les populations qui sont moins enclines à participer.

Considérant que les deux interventions en exercice physique à composantes multiples ont amélioré la fonction physique et l'état nutritionnel, nous avons déterminé que six semaines d'une intervention d'exercice en groupe entraînaient des avantages fonctionnels et nutritionnels similaires à une intervention en groupe plus longue de douze semaines, lorsque les deux sont poursuivies à domicile jusqu'à vingt-quatre semaines. Ces résultats fournissent des informations précieuses pour la conception d'interventions d'exercice physique pratiques, réalisables et de bonne efficacité médico-économique après une hospitalisation chez les personnes âgées.

D'autre part, bien que les deux interventions aient entraîné des bénéfices similaires ou presque égaux en matière de fragilité, il n'en a pas été de même pour la sarcopénie. Par conséquent, nous avons déterminé qu'une intervention d'exercices à multicomposantes en groupe de 6 semaines est suffisante pour inverser la fragilité. D'autres études avec des échantillons plus importants sont justifiées pour clarifier l'effet de ces différentes durées d’intervention sur le traitement et la prévention de la sarcopénie.

La myostatine peut être un biomarqueur utile pour identifier et suivre la sarcopénie chez les personnes âgées au décours d’une hospitalisation. Néanmoins, la myostatine et la follistatine sont moins performantes dans l’identification de la fragilité que les tests physiques. D'autres études utilisant des échantillons de plus grande taille et ces myokines ainsi que d'autres biomarqueurs sont justifiées.

À la lumière de ce qui précède, nous avons montré des stratégies pour améliorer l'accessibilité et augmenter la participation des personnes âgées aux programmes

d'exercices physiques après une hospitalisation. De même, si l'on tient compte de ces résultats, de l'absence d'effets négatifs associés aux interventions, de la bonne tolérance et des taux d'observance globalement élevés observés, ces résultats fournissent des informations précieuses pour la conception d'interventions d'exercice physique pratiques, réalisables et performantes sur le plan médico-économique après une hospitalisation chez les personnes âgées.

LABURDURAK

ABBREVIATIONS

LABURDURAK / ABBREVIATIONS

ACT: Arm-Curl Test
ACSM: American College of Sports Medicine
AHA: American Heart Association
ANOVA: analysis of variance
ANZCTR: Australian and New Zealand Clinical Trials Registry
ASM: Appendicular Skeletal Muscle mass
AUC: Area Under the Curve/ Kurba azpiko area
BMC: Bone Mineral Content
BMD: Bone Mineral Density
BMI: Body Mass Index
CI: Confidence Interval
CC: Calf Circumference
CCI: Charlson Comorbidity Index
CST: 30-s Chair-Stand Test / Chair Stand Test
DXA: Dual-Energy X-ray Absorptiometry
EBA: Eskala Bisual Analogikoa
ELA: Epe Luzeko Adarra
ELISA: Enzyme Linked Immunosorbent Assay
EMA: Epe Motzeko Adarra
EQ-5D-5L: EuroQol–5 Dimension
EWGSOP2: European Working Group on Sarcopenia in Older People
GMI: Gorputz-Masaren Indizea
GS: Gait Speed
HUA: University Hospital of Araba / Arabako Unibertsitate Ospitalea
INE: instituto nacional de estadística
ISAK: International Society for the Advancement of Kinanthropometry
IQR: interquartile range
LGB: Long-term Group-based Branch
LPA: Light Physical Activity
η^2: Eta squared
MMSE: Mini Mental State Examination
MNA: Mini Nutritional Assessment
MNA-SF: Mini Nutritional Assessment Short Form
MoCA: Montreal Cognitive Assessment
MRI: Magnetic Resonance Imaging
MVPA: Moderate to Vigorous Physical Activity
PE: Physical Exercise
PTS: points
QoL: Quality of Life
RCT: Randomized Controlled Trial
ROC: Receiver Operating Characteristic/ hartzailearen ezaugarri operatiboa
SD: Standard Deviation

SE: Standard Error
SEN: sensitivity
SFT: Senior Fitness Test
SGB: Short-term Group-based Branch
SPE: specificity
SPMSQ: Short Portable Mental Status Questionnaire
SPPB: Short Physical Performance Battery
STROBE: Strengthening the Reporting of Observational Studies in Epidemiology
U: Mann Whitney's U
UB: Université de Bordeaux / Bordeleko Unibertsitatea
UPV/EHU: Universidad del País Vasco/Euskal Herriko Unibertsitatea
χ^2: chi-square test
WHO: World Health Organization
WHR: Waist-to-Hip Ratio
1-RM: one-repetition maximum
5-SQUAT: sit-to-stand five times
6mWT: 6-minute Walking Test
8-ft TUGT: 8-ft Timed Up-and-Go Test
8TUG: 8-Foot Timed Up and Go Test / altxa, ibili, bira eta eseri

1.

AURREKARI NAGUSIAK

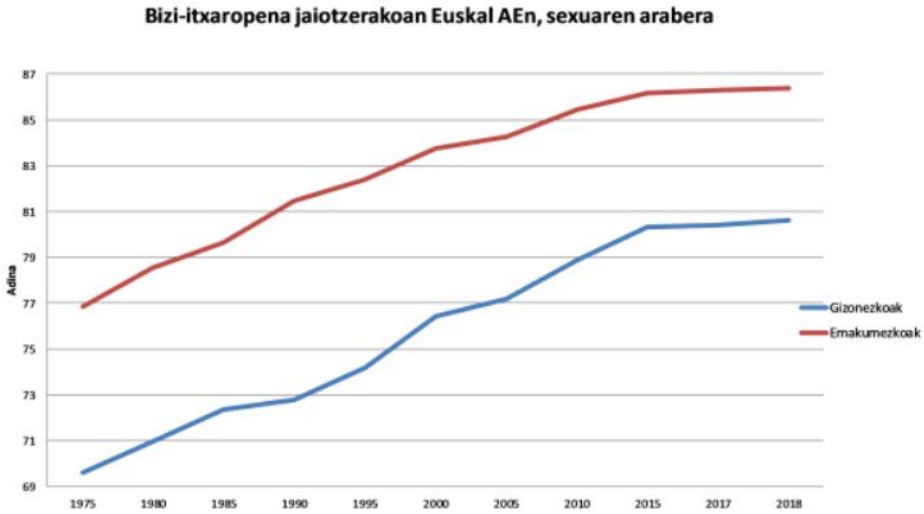
BACKGROUND

1. AURREKARI NAGUSIAK / BACKGROUND

1.1. Biztanleriaren zahartzea eta gizartean duen eragina

Bizi-itxaropena mundu maila igotzeak, mundu osoan biztanleriaren zahartzea dakar beraz fenomeno honek hirugarren adineko pertsonak geroz eta gehiago izatea sortaraziko du (Scully, 2012). Esaten da 2050. urterako, bizi-itxaropenaren handitzea eta jaiotza-tasaren txikitzea dela medio, 60 urtetik gorako biztanleria gaur egungoaren bikoitza izatera pasako dela, hots, mundu mailako biztanleria osoaren % 11tik % 22-ra pasaz (WHO, 2007).

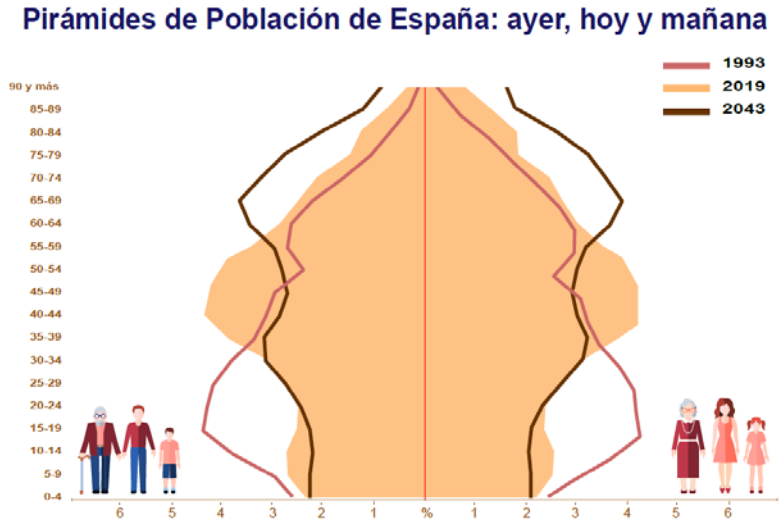
Europar Batasuneko beste herrialdeekin konparatuz gero, Euskadin bizi-itxaropena oso altua da; emakumeetan Europar Batasuneko altuena (86,2 urte) eta gizonetan (80,3 urte) Italiarekin berdinduta bigarren altuena (Eustat, 2018). Euskadiko gizon zein emakumeek bizi-itxaropenaren etengabeko hazkundea izan dute, aurten emandako datuak kontuan hartuz gero emakume (% 0,02) zein gizonek (% 0,03) goranzkoa izan dute. Fenomeno demografikoak aztertzeko egindako adierazleen emaitzeei eta behean ikusgai dagoen irudiari erreparatuz gero, gaur egun, Euskadin jaiotzen den emakumeen bizi-itxaropena 86,4 urtekoa da eta gizonezkoen kasuan 80,6 urtekoa (Eustat, 2020).



1. Irudia: Bizi-itxaropena Euskadin. **Iturria**: Eustat, 2020.

Bestalde jaiotza-tasari dagokionez ez dira datu hain pozgarriak, Euskadik Europar Batasuneko jaiotze-tasa baxuenetarikoa baitu. Euskadin 2017an, 1.000 biztanleko 7,8 jaiotza erregistratu ziren, eta hori Europar Batasuneko herrialdeetan egon zen batez bestekoaren (9,9) oso azpitik dago, soilik Italiaren (7,6) aurretik kokatuta. (Eustat, 2019). Hau dena ikusirik, adinaren piramidea guztiz aldatuko dela aurreikusi da. Izan ere, 65 urtetik gorakoak 2000. urtean Euskadiko biztanleria osoaren % 17,2 ziren, egun, 2020an, % 22,8 dira eta 2031ean % 28,2 izango direla iragartzen da. Sexuen arteko banaketa orekatzen joango da, nahiz eta oraindik hirugarren adineko pertsonetan gehiengoak

emakumeak izaten jarraitu; 2020an 65 urtetik gorako biztanlerian % 57,4 emakumeak izatetik, 2031an % 56,4 izatera pasako dira (Eustat, 2018b). Hori gutxi ez balitz, 65 urte eta gehiagokoak ugariagoak lirateke egungo norabidea jarraituz gero eta migratze-saldoaren araberako agertoki guztietan. Hurrenez hurren, 2061erako aldaketa horien hazkundeak % 43,4 edo % 72 lirateke (Eustat, 2018d). Begirada soilik Araban zentratuz gero 65 urtetik gorakoak 2010ean % 17,2 izatetik, 2019an % 21,1 izatera pasa ziren (INE, 2019). Berriz estatuan zentratzen bagara, 2 irudian ikusi daitekeen moduan, piramide demografiakoak 27 urtetan ikaragarrizko eraldaketa izan du eta etorkizuna ere norabide berean doala argi ikusi daiteke 2043. urtean iragarritako datuekin (INE, 2020).



2. Irudia: Piramide demografikoak. Iturria: INE, 2020.

Orohar, osasun gastua pertsonako areagotzen doa zahartzen goazen heinean, nahiz eta adinaren eta osasun gastuen arteko lotura lineala ez izan. Hala ere, geroz eta hirugarren adineko pertsona gehiago egongo direnz, osasun baliabideen erabilera eta beraz osasun gastua esponentzialki igoko dela aurreikusi da (Carone, 2005). Argi dago osasun publikoaren politika eta garapen sozio-ekonomikoaren arrakastaren ondorio dela populazioaren zahartzea, baina era berean. errealitate berri hau, gizartearen erronka garrantzitsuenetariko batean bihurtu da (The Lancet Public Health, 2017).

Euskadiko osasun zerbitzuen azken datuek argi adierazten duten ospitaleko sarrerak gehitu egin direla biztanleko, nahiz eta ospitaleko egonaldiak murriztu, hau da, arreta (ospitaleratzea, kanpoko kontsultak, jarduera kirurgikoa) jaso duten pertsonen kopurua gehitu egin da. Osasunaren gaineko azken inkestaren arabera (2013), emakumeak gizonezkoak baino maizago doaz medikuarengana. Inkestan emakumeen % 87 azken 12 hilabeteetan medikuari kontsultaren bat egin ziotela esan zuten, gizonen kasuan berriz % 78. Adin tarteak kontuan hartuta, adingabeak dira medikuarengana sarrien joaten direnak, baina 65 urte eta gehiagoko pertsonetan zentratuz gero, horien % 90-etik gora gutxienez urtean zehar behin joan dira medikuarengana (Eustat, 2014).

Geroz eta urte gehiago bizitzeak osasun errekurtsoen erabileran eragiteaz gain, bizi garen urteen kalitatean ere eragiten du. Esan ohi den bezala bizitzari urteak gehitzea ondo dago, baina garrantzitsuagoa da urte horiei bizia gehitzea. Euskadiko osasun inkestara itzuliz, 2007tik 2013ra bitartean gizonetan desgaitasunik gabeko bizi-itxaropena mantendu arren emakumeetan jaitsi egin zen. Baina desgaitasunarekin bizitako urte kopuruak begiratuz gero, urte tarte horietan, 3,1 urte emakumeen kasuan eta 1,7 urte gehitu da gizonen kasuan (Eustat, 2014). Ondorioz, populazioaren bizi-itxaropena luzatzea beti ez dator bat bizi-kalitate hobe edo egokiagoarekin (Kress eta Herridge, 2012), hori dela eta desgaitasunik gabe ahalik eta gehien bizitzea gaur egungo erronken artean ezarri da (Crimmins eta Beltrán-Sánchez, 2011).

Hau guztia dela eta, bizitza aktibo eta osasuntsuak, ariketa fisikoak eta jarduera fisikoak gaitasun funtzional, autonomian, bizi-kalitatean, egoera nutrizionalean eta ospitalizatzeko arriskuen gutxitzean izan dezaketen eraginaren inguruan interesa sortu da, eta ondorioz azken urteotan pertsona nagusiengan zer nolako eragina izan dezakeen ere asko ikertu da.

1.2. Zahartze-prozesua

Zahartzea prozesu jarraia, graduala eta unibertsala izateaz gain itzulezina da, bizi guztikoa eta oso aldakorra. Aldaketa horiek pertsona bakoitzarengan erritmo eta modu ezberdinean ematen diren aldaketa funtzional, fisiko, biologiko eta sozialei eragiten die. Zahartzea morbilitatearen, faktore genetikoen eta hala nola nutrizioa, bizimodua eta jarduera fisikoa bezalako beste faktore batzuen bidez azal daiteke eta gehien bat funtzio fisiologikoen narriadura progresiboan ezaugarritzen da (Del Pozo-Cruz eta lank., 2013; Kirkwood, 2017). Degenerazio prozesu honek eragiten dituen funtzio fisiko zein kognitiboen gainbeherek, eguneroko jarduerak aurrera eramatea oztopatuz gaitasun funtzionalaren galera eragiten dute (Rodríguez-López eta lank., 2014; Blazer eta lank., 2015). Era berean, bizi kalitatea murrizketaren eragile nagusienetarikoa eguneroko jarduerak gauzatzeko ezintasuna edo gaitasun eza da (Keeler eta lank., 2010).

1.2.1. Kognitiboki

Adina aurrera joan ala, neuronen galera jarraitua ematen da eta ondorioz baita neurotransmisoreen gutxitzea ere (Mather, 2016). Beraz egoera aldaketa honek funtzio fisiko zein kognitiboaren beherakadarekin erlazionatuta egoten dira eta faktore ezberdinek (ingurumena, genetika eta bizi kalitatea) eragina dute (Nyberg eta lank., 2012). Zahartzaroan zehar eguneroko bizitzaren funtzionamenduan eragina izan dezaketen aldaketa kognitibo arinak direla medio funtzio kognitiboak behera egiten du (Harada eta lank., 2013). Nahiz eta aldaketa hauek menpekotasuna handituz zein

bizi kalitatea gutxituz pertsonen autonomian eragina izan dezaketen, prozesu hau oso aldakorra izan ohi dela ez dugu ahaztu behar (Blazer eta lank., 2015).

Zahartze prozesuan zehar, gaixotasun zehatz batzuek edota hauskortasuna bezalako sindromeak medio direla, adin bereko pertsonen artean batzuek funtzio exekutiboaren eta prozesatzeko abiaduraren zenbait probatan beste batzuek baino emaitza txarragoak izan ohi dituzte (Langlois eta lank., 2012). Bestalde, nahiz eta erreakzio denbora eta oroimena bezalako funtzioak okertzen diren jakin arren, adimena eta jakituria bezalako beste funtzio batzuk hobetu edo mantentzen direla ikusi ahal izan da (Blazer eta lank., 2015).

1.2.2. Funtzionalki

Zahartze-prozesuak gorputz-osaeran aldaketak eragiten ditu, muskulu-masa eta hezur-masa murriztuz eta gantz-masa handituz, eta horrek errendimenduaren murrizte funtzionala dakar (Brady eta lank., 2014). Errendimendu funtzionalaren galera progresibo hori zahartzaroarekin eta osasunarekin lotutako arazo garrantzitsuenetariko bat da. Esan bezala, adinean aurrera egin ahala, beheko gorputz-adarretako muskulu multzoetan muskulu-masa gehiago galtzen da. Gazteekin alderatuz geroz, zeinbait muskuluetan berauen zeharkako azalera % 40, hanketako indarra % 70, artikulazioen mugikortasuna % 50 eta koordinazio neuromuskularra % 90 murrizten dira (Casas-Herrero eta Izquierdo, 2012).

Funtzio fisiko eskasa desnutrizio, erorketa, erikortasun handi, hilkortasun eta ezgaitasun handiekin eta bizi kalitatea murriztearekin lotzen da (Goodpaster eta lank., 2006; Wolinsky eta lank., 2007; Bradley, 2013; Hu, 2017). Baita ere, funtzio fisikoaren gainbeheran zentratuta jarraituz, zahartze prozesuak oreka, indarra eta gaitasun aerobikoaren murrizketa dakar eta ondorioz ibili edo altxatzeko jarduerak burutzeko eragin zuzena izanez (Goodpaster eta lank., 2006; Reid eta lank., 2008; Milanović eta lank., 2013). Hala, funtzio fisikoa galtzea erronka bat da helduentzat, eta osasunarekin eta karga ekonomikoarekin lotutako baliabideen eskaria handitzea dakar (Tieland, eta lank., 2018).

1.2.3. Nutrizionalki

Elikagaien ingesta, oro har, jaitsi egiten da zahartzearekin batera, besteak beste, horri zahartzearen anorexia deritzo. Alegia, zahartzearen anorexia gosearen murrizte fisiologikoari eta adinean aurrera egin ahala jakiak hartzen uzteari dagokio. Jateko gogoa galtzeak lagundu egiten du mantenugaiak gutxitzen, eta horrek pisua galtzea eta azpi nutrizioa edo desnutrizioa iragartzen ditu. Eguneko batez besteko energia-kontsumoa % 30 murriztu daiteke 20 eta 80 urte bitartean (Visvanathan, 2015).

Zenbait faktore fisiologikoez gain baita ere faktore sozialengatik, adinekoek elikagai gutxiago hartzeko joera dute, eta, ondorioz, askotan ez dituzte betetzen energia- eta proteina-baldintza egokiak (Hung eta lank., 2019). Hori dela eta, dieta osasuntsu eta orekatua izatea erronka izan daiteke adinekoentzat, bereziki haiek dituzten elikagai jakin batzuen beharrak biztanleria osoarenak baino handiagoak direlako. Ondorioz, esan daiteke desnutrizioaren prebalentzia handitu egiten dela adinak aurrera egin ahala (Siddique eta lank., 2017).

1.3. Hauskortasuna eta Sarkopenia

Azken urteotan, osasun politika zein ikerketa munduan populazioaren zahartzearekin batera hauskortasunaren eta sarkopeniaren inguruan interes handia sortu da. Hauskortasuna eta sarkopenia baldintza itzulgarritzat hartzen dira (Yoo eta lank., 2018), eta, beraz, oso garrantzitsua da garaiz detektatzea.

Lehen honen inguruan, hauskortasuna, hainbat ikerketa argitaratu arren, ez dago definizio bateratu ezta estandarizaturik ere (Morley eta lank.,2013; Rockwood eta Howlett, 2018). Hori dela eta hauskortasuna identifikatzeko hainbat eskala edo test diseñatu eta erabiltzen dira (Rodríguez-Mañas eta lank., 2013), hala nola, Frailty Index, SPPB, Study of Osteoporotic Fracture Index, Tilburg Frailty Indicator, Frailty Scale edota Phenotype of Frailty. Orain arte ikerketetan ohikoena eta erabiliena Fried-en hauskortasun irizpidean oinarritutakoa eskala izan da (Bouillon eta lank., 2013). Berau eta bere lankideak hauskortasuna ezaugarri fisiko edo fenotipoetan oinarrituz deskribatzen lehenak izan baitziren (Fried eta lank., 2001). Beraz, hauskortasuna neurtzeko, metodologia atalean irakur gai dagoen moduan, guk azken hau hautatu genuen. Adineko pertsonen artean hauskortasuna ohikoa izaten da eta honako sintomak izaten dituzte: neke goiztiarra, astenia, jarduera fisiko eskasa, muskuluaren indar eta erresistentzia gutxitzea, pisu galera, sintoma depresiboak eta hiporexia (Fried, eta lank., 2004); horiez gain, ibileran eta orekan asaldura, mugimendu motel, mugikortasun eza, osteopenia, malnutrizioa, desgaitasuna, narriadura funtzionala, ospitalizazio eta hilkortasun arrisku handiagoa dakar (Fried eta lank., 2004; Garcia-Garcia eta lank., 2011; Morley eta lank., 2014; Vellas, 2016). Bestetik, garrantzitsuada aipatzea komorbilitatea eta desgaitasuna hauskortasunarekin batera agertu arren, entitate kontzeptual zein kliniko ezberdinak direla, komorbilitate edo desgaitasunik izan gabe hauskortasuna pairatu daitekeelako (Fried eta lank., 2004; Rodríguez-Mañas eta lank., 2013).

Bien bitartean, European Working Group on Sarcopenia in older People (EWGSOP) lan taldeak 2010. urtean adinarekin erlazionaturiko sarkopeniaren definizio kliniko-praktikoa eta adostutako irizpide diagnostikoak zehazten zituen dokumentua argitaratu

zuen (Cruz-Jentoft eta lank., 2010). Gerora, aurreko urtean berrikusitako definizio zein diagnosi prozesua argitaratuz (Cruz-Jentoft eta lank., 2019). Beraz adosturiko eta berrikusitako definizioa honakoa da: Sarkopenia muskulu-nahaste eskeletiko progresibo eta orokortua da, eta muskulu-masa eta funtzioa azkar galtzea dakar. Sarkopenia identifikatzeko parametroak muskuluaren kantitatea eta funtzioa dira. Horrenbestez, aldagai kuantifikagarriak indarra, masa, eta errendimendu fisikoa dira (Cruz-Jentoft eta lank., 2019). Hauskortasunean bezala, sarkopeniak kontrako gertaerak izateko arrisku handiagoa du, hala nola ezgaitasuna, autonomia galera eta aldez aurretiko heriotza (Fielding eta lank., 2011). Europar Batasuneko 65 urtetik gorako pertsonen % 20-ri eragiten diola uste da, eta hurrengo hiru hamarkadetan % 63-ra iritsiko dela kalkulatzen da (Ethgen eta lank., 2017). Ondorioz, sarkopenia hirugarren adinekoentzako mehatxu bat da, eta osasun-kostu handiak eragiten ditu (Santilli eta lank., 2014; Miljkovic eta lank.,2015).

1.3.1. Biomarkatzaileak

Ingurune klinikoetan kokatzen bagara ezin dugu ukatu hauskortasun eta sakopeniaren inguruko ebaluazio zehatzak egitea beti ez dela erraza. Hauskortasun-indizeek, oro har, proba fisikoak eta galdera-sortak izaten dituzte, eta, askotan, zaila izaten da horiek egitea eskatzen duten denbora dela eta. Sarkopeniaren diagnostikoak, berriz, proba garestiak eskatzen ditu, hala nola energia bikoitzeko X-izpien absorptiometria (DXA) (Guglielmi eta lank., 2016) edo erresonantzia magnetikoa (Lee eta lank., 2019). Hauskortasuna edo sarkopenia identifikatzeko tresna alternatibo gisa, indarra (Pinheiro eta lank., 2016; Lee eta lank., 2017), abiadura (Lee eta lank., 2017), arintasuna edota oreka dinamikoa (Savva eta lank., 2013) neurtzeko erabiltzen diren banakako probak proposatu dira. Hala ere, proba horiek ospitale-inguruneetan gauzatzea zaila izan daiteke egoera eta espazio berezitzat hartu behar baita, hala nola oso zaurgarriak diren pazienteak eta denbora- eta/edo espazio-mugak agertu daitezkeelako.

Biomarkatzaile molekularrak prozesu fisiologiko eta patogenikoen adierazle gisa erraz neur eta ebaluatu daitezke (Biomarkers Definitions Working Group, 2001). Funtzio fisikoaren narriadura hauskortasun fisikoaren eta sarkopeniaren nukleo amankomuna bezala adieraz daiteke (Cesari eta lank., 2014). Horrenbestez, muskulu-funtzioari lotutako biomarkatzaile molekularrak (besteak beste) ikertu behar dira, hauskortasun- eta/edo sarkopenia-biomarkatzaile gisa duten potentziala zehazteko asmoz.

Miostatina muskulu eskeletikoan oso ugaria den zitokina da, baina gantz-ehunean eta bihotz-muskuluan ere aurki daiteke (White eta Le Brasseur, 2014). Miostatinak proteolisia hobetu eta muskulu eskeletikoan proteinen sintesia inhibitzen du, horrez

gain muskulu-masaren erregulatzaile negatibo sendoa da (Rodgers eta Garikipati, 2008). Haatik, hauskortasun eta sarkopeniarekin lotutako parametroek miostatinarekin dituzten asoziazioen berri ematen duten ikerketek emaitza kontraesankorrak erakutsi dituzte. Batzuek miostatinaren eta muskulu-masaren (Yarasheski eta lank., 2002) edo funtzio fisikoaren (Fife eta lank., 2018) arteko lotura negatiboa aurkitu dute; beste batzuek, berriz, kontrakoa adierazi dute (Bergen eta lank., 2015): miostatina-kontzentrazio handiagoa, muskulu-masa handiagoarekin eta muskulu-funtzio hobearekin lotua. Gure ikerketa berriak, hirugarren adineko egoitzetako egoilarretan, hauskortasun eta miostatinaren arteko lotura negatiboa aurkitu zuen (Arrieta eta lank., 2019).

Folistatina proteinak miostatinaren jarduera inhibitu eta muskulu-hazkundea sustatzen du (Lee eta lank., 2010). Hala ere, miostatinarekin bezala, folistatina funtzio muskulular eta fisiko (Liaw eta lank., 2016), zahartze eta adinarekin zerikusia duten hauskortasun eta sarkopeniarekin (Ratkevicius eta lank., 2011; Negaresh eta lank., 2019) nola asoziatzen den aztertzertutako ikerketek, emaitza eztabaidagarriak azalerazi dituzte. Ondorioz hauskortasun eta sarkopeniaren biomarkatzaile molekular gisa miostatina eta folistatinaren balio potentziala kontuan izatekoa dela deritzogu.

1.4. Ospitalizazioaren eragina

Gero eta handiagoa den ebidentziak iradokitzen du adineko pazienteen funtzio fisikoa eta kognitiboa murriztu egiten dela, eritasun akutuagatik ospitaleratu ondoren (Graf, 2006; Mathews eta lank., 2014). Gainera, gaitasun fisiko eta kognitiboen galerak altaren ondorengo hilabeteetan ere jarrai dezake (Wilson eta lank., 2012). Murrizketa funtzionalak lotura zuzena izan du ospitaleratu eta hurrengo urteko emaitza negatiboekin, mendekotasuna barne, instituzionalizatzeko eta are hiltzeko arrisku gero eta handiagoa (Campbell eta lank., 2004). Alta hartu eta urtebetera, gastu mediko osoak handitu egiten dira narriadura funtzionalaren proportzioan, eta horrek adierazten du ospitaleratu ondoren funtzio fisikoa eta kognitiboa galtzeko izan dezakeen eragin ekonomikoa (Greysen eta lank., 2017).

Zahartze-prozesuari estresa gehitzeak, gaixotasunagatik edo ospitaleratzeagatik, desegokitzapena bizkortu egiten du normalean. Adineko pazienteen ospitaleratzea muskulu-indarra gutxitzearekin lotzen da, eta muskulu-masa galtzea eta nutrizio-egoerak eta bizi-kalitateak okerrera egitea (Van Ancum eta lank., 2017). Estresaren eta narriaduraren arteko lotura sendoak handitu egin dezake ondorio negatiboen arriskua, hala nola mendekotasuna edo heriotza-tasa (Oliveira eta lank., 2009; Deutz eta lank., 2019; Sauer eta lank., 2019), eta horrek bereziki paziente zaharrenei eragiten die (Chen, eta lank., 2008). Gaitasunen gutxitze horrek altaren ondorengo hilabeteetan jarrai

dezake (Chen eta lank., 2008; Wilson eta lank., 2012), baita ospitaleratu eta urtebete baino gehiagora (Gill eta lank., 2010). Gainera ospitalizazioa bukatu eta esku-hartze egokirik gabe, egoera akutu horri lotutako ondorio eskasak kronikoki hauspeatzeko ahalmena dute (Suetta eta lank., 2007; Kanach eta lank., 2018).

Zahartze osasuntsuan, muskulu-masaren galera % 3tik % 8ra bitartekoa da hamarkada bakoitzeko (Mitchell eta lank., 2012). Hala ere, murrizketa hori are gehiago areagotzen edo nabarmentzen da gaixotasun akutu edo kronikoagatik edota jarduerarik gabeko aldi akutu bat, hala nola ospitaleko egonaldi bat, dela eta (Witard eta lank., 2016). Ospitaleratu ondoren, adineko pertsonak kontrako edozein gertaera garatzeko zaurgarriagoak dira (Krumholz, 2013). Gero, sendatzea azkartzeko eta ospitalera berriz ez onartzeko esku-hartze goiztiarrak garrantzitsuak izango dira (Deer eta lank., 2019). Desnutrizioa ohikoa da adineko gaixoetan (Hung eta lank., 2019), eta horregatik alta eman eta berehala elikadura eta ariketa fisikoa konbinatzen dituzten esku-hartzeak ezartzea garrantzitsua da.

Ospitaleratzea hauskortasun eta sarkopeniarekin lotuta egon daiteke. Hauskortasun-sindromea oso ohikoa da ospitaleratuta dauden heldu zaharrenetan (Cunha eta lank., 2019), eta sarkopenia modu akutuan ager daiteke ospitalean sartzen diren bitartean, bereziki heldu nagusietan (Cruz-Jentoft eta lank., 2019). Hauskortasuna (Aranha eta lank., 2020) eta sarkopenia (O'Brien eta lank., 2018) ospitalera itzultzeko arrisku handiagoarekin ere lotzen direnez, ospitalizazioaren eta hauskortasun/sarkopeniaren arteko erlazioak bizio-zirkulu bat sor lezake, eta horrek gainbehera funtzional handia eragin lezake.

Adineko pazienteen ospitaleratzea indar gutxitzearekin eta muskulu galera azkartzearekin lotzen da, eta beraz bizi-kalitateak okerrera egiten du (Van Ancum eta lank., 2017). Gaitasun funtzionalaren murrizte progresibo hori zahartzearekin lotutako arazo garrantzitsuenetariko bat da. Funtzio galera hori desnutrizio, erorketa, erikortasun handi, hilkortasun eta ezgaitasun arazo handiekin lotzen da, eta guzti horrek bizi-kalitatea murrizten du (Goodpaster eta lank., 2006).

1.5. Ariketa fisikoaren eragina hirugarren adineko pertsonetan

1.5.1. Esku-hartze motak

Ariketa fisikoko esku-hartzeen artean, bereziki, komunitatean bizi diren heldu nagusien artean osagai anitzeko ariketa fisikoan oinarrituriko programak indarra, oreka, gaitasun aerobikoa eta orokorrean funtzionaltasuna hobetzeko eraginkorrak direla erakutsi dute (Paw eta lank., 2008; Cadore eta lank., 2013; Pahor eta lank., 2014; Arrieta eta lank., 2018). Hau dela eta, gehien gomendatzen diren ariketa fisikoko esku-

hartzeak hauexek dira, osagai anitzekoak, non indarra, oreka edo gaitasun aerobikoa bezalako osagaiak konbinatuta landu ohi diren. Indarra, erresistentzia eta oreka lantzeko entrenamendua duten osagai anitzeko programak zahartzearekin lotutako ondorio kaltegarriak arintzeko eraginkorrak dira (Cadore eta lank., 2013; Pahor eta lank., 2014; Arrieta eta lank., 2018).

Orain arte publikatutako ikerketen gehiengoak egoera fisikoko osagaien konbinaketa eta esku-hartze desberdinak (taldekako saioak edo etxean bakarka) erabili dituzte (Lacroix eta lank., 2016); batzuk indarra eta oreka konbinatuz, beste batzuk indarra eta gaitasun, eta beste batzuk hiruen bateratze bat jorratu dute. Era berean, egoera fisikoko osagai horiek lantzerako orduan atsedena, ariketa motak, maiztasuna (astean zenbat saio), intentsitateak (arina edo moderatua) eta bolumena (errepikapen zein serie kopuruak) bezalako ezaugarriak ikerketen artean ezberdinak dira. Ondorioz esan daiteke osagai anitzeko esku-hartzeen artean heterogeneotasun metodologikoa dela nagusi, eta zer esanik ez ospitalizazioan edo ospitalizazio ostean. Horregatik ezinbestekoa da egoera edo ingurune honetarako osagai anitzeko ariketa fisikoko esku-hartze eraginkorrena zehaztea.

Ospitaleratze akutuan edo ospitaleratze akutuaren ondoren egiten direnean, esku-hartze horiek muskulu-indarra eta gaitasun funtzionala handitzen dituzte, eta funtzio fisikoa eta egoera kognitiboa hobetzeko eraginkorrak dira (Timonen eta lank., 2002; . Stevens-Lapsley eta lank., 2016; Martínez-Velilla eta lank., 2019; Sáez de Asteasu eta lank., 2019). Hala ere, ospitalizazioan ariketa fisikoa egitea zaila izaten da, gaixotasunaren larritasuna eta beharrezko arreta zein zaintza medikoaren konplexutasuna direla eta. Ospitalizazio osteko ariketa fisikoko programa gehienak bihotz- eta birika-patologiak dituzten gaixoekin edota aldaka zein belaun interbentzio kirurgiko baten ondoren erabiltzen dira (Benzo eta lank., 2015; Ruano-Ravina eta lank., 2016; Mudge eta lank., 2018). Hala ere, ikerketa gutxik ebaluatzen dituzte adinekoengan ospitalizazioaren ondoren eta beraien tratamenduaren barne izan gabe ariketa fisiko programa batek zer nolako eragina sortzen duen (Stevens-Lapsley eta lank., 2016; Bäck eta lank., 2015). Gainera, ariketa fisikoko esku-hartzeen kostu sozial eta ekonomikoa kezkagarria da. Beraz, ospitaleko alta jaso ondoren funtzio fisikoa azkarrago berreskuratzeko esku-hartze eraginkor eta jasangarriak egitea justifikatuta dago (Deer eta lank., 2016).

Ariketa fisikoko esku-hartze gehienak taldeka edo etxean bakarka sailkatu daitezke. Ingurune kliniko batean, taldeetan oinarritutako saioak langile kualifikatuek kontrolatzen dituzte. Horrela, ariketaren teknikan arreta eta errendimendu egokia bermatzen dira, eta, hala, ariketak egiteko kargak eta zailtasuna handitu eta optimizatzen dira, eta jarraipena errazago egiten da (Lacroix eta lank., 2016; Tsekoura

eta lank., 2018). Hori dela eta, entrenatzaile esperimentatuak eta instalazioetarako garraioa beharrezkoak dira, eta beraz programa horiek epe luzera mantentzea zailagoa egiten da. Aitzitik, etxean oinarritutako ariketa programek taldeetan oinarritutakoarekin konparatuz, ariketen-ikuspegitik, zenbait onura dituzte, hala nola ariketa bizi-estiloaren lehentasunei egokitzea, parte-hartzailearen autonomia, denboran malgutasuna, gizabanakoarentzako kostu txikia eta bidaiatzeko behar eza. Hala ere, etxean gauzaturiko programek, programara atxikitzeko autodiziplina indartsu baten beharra eta programaren izaera sozialaren falta (azken hau talde ariketaren elementu positibotzat jotzen baita) bezalako mugak dauzkate (Hill eta lank., 2015). Normalean, ikuskapenaren intentsitatea zenbat eta handiagoa izan, orduan eta handiagoak izango ohi dira hobekuntzak (Sherrington eta lank., 2014; Deer eta lank., 2019), baina ez dago adostasunik helduengan zein programak eskaintzen duen hobekuntzarik handiena.

Programa batzuetan, errendimendua eta atxikimendua errazteko hasierako saio gainbegiratuen ondoren, etxean oinarritutako saio-aldi bat dago. Honela, gure kasuan bezala, programa horiek bi esku-hartze motak aprobetxa ditzakete. Hain zuzen, epe luzera taldeetan oinarritutako esku-hartzea amaitu ondoren jarraipena etxean edo komunitatean egin zirenean ondorio positiboagoak aurkitu zirela argitaraturiko datuak aztertuz gero erabaki hori indartzen da (DeVito eta lank., 2003; Kosse eta lank., 2013; Kanach eta lank., 2018). Kasu horretan, taldean oinarritutako osagaiaren luzera faktore mugatzailea izan liteke, kostu ekonomiko eta soziala dela eta. Beraz, kalitate handiko zorizko saiakuntza kontrolatuak proposatu dira ikuspegi gradualak ebaluatzeko, ariketa gainbegiratzeko etapa desberdinak aplikatuz (Lacroix, eta lank., 2017).

1.5.2. Ariketa motak

Ariketa fisikoko programa bat planifikatzerako orduan, frekuentzia, intentsitatea, iraupena, bolumena, indibidualizazio, espezifikotasuna, karga progresibo, atsedenaldi eta errekuperazio printzipioak kontuan hartu behar dira (Garber eta lank., 2011; de Souto Barreto eta lank., 2016; Zaleski eta lank., 2016). Intentsitateari dagokionez, nahiz eta intentsitate baxuko (Cichocki eta lank., 2015), altuko (Toots eta lank., 2016; Zaleski eta lank., 2016) edota mistoko (moderatu+altuko) (Zaleski eta lank., 2016) ariketa fisikoko programak osasuneko zenbait parametrorentzat onuragarriak izan daitezkeela ikusi den, hirugarren adineko zaugarrieenentzako intentsitate moderatua da gehien gomendatzen dena (de Souto Barreto eta lank., 2016) denek altua ezin baitute egoki toleratu (Zaleski eta lank., 2016). Printzipio hauek oinarri hartuta, adinduen egoera fisikoa zein kognitiboa mantentzeko indarra, lan aerobikoa, oreka

eta malgutasuna lantzen dituen ariketa fisikoko programak aholaktzentzen dira (ACSM, 2013; de Souto Barreto eta lank., 2016; Zaleski eta lank., 2016).

Astean bi eta bost saio bitarte burutzea gomendatzen da, saio bakoitzak gutxienez 30 minutu eta gehienez 60 minutu iraupena izanik (ACSM, 2013; Zaleski eta lank., 2016). Asteko saioen artean, 48 orduko tartea errespetatzea ere aholkatzen da, deskantsoa programatzean kontuan hartzea beharrezkoa baita (ACSM, 2009; Garber eta lank., 2011; de Souto Barreto eta lank.,2016).

1.5.2.1. Indarra

Muskulu galera moteltzeko Indar entrenamendua funtsezkoa da, masa eta funtzio muskularra gehitzean gain eta oreka arazoak ere murrizten dituela frogatu baita eta (Montero-Fernandez eta Serra-Rexach, 2013). Hare gehiago, astean zehar 2-3 saioen bitartez adineko pertsonetan muskuluen ahultasuna hobetu, zenbait muga funtzional gainditu eta desgaitasun fisikoa murriztu daitekeela frogatu da (Liu eta Latham, 2009). Indar ariketak burutzen hasiko dituzten adineko pertsonentzat, beraien indar maximoaren (RM1) % 40-50 bitarteko intentsitatea erabiltzeko gomendatzen da, eta gerora, egokitzapen fasea burutu ondoren % 60-70 RM1 (Garber eta lank., 2001; ACSM, 2013). Errepikapen maximo bateko neurketa egin ezin denean, indar ariketen intentsitatea zehazteko 0tik 10erako eskala subjektiboa erabiltzea adierazten da: 5-6 intentsitate moderaturako eta 7-8 intentsitate alturako (Nelson eta lank., 2007; Zaleski eta lank., 2016).

Aurrez esan bezala, hasiberriek egokitzapen fase egoki bat izateko lehen asteetan intentsitate baxuko ariketak burutzea aholkatzen da. Ondoren, % 60-70 RM1 intentsitatean 8-10 ariketa eta gehienez 8-15 errepikapeneko 2-4 serie burutuz (Garber eta lank., 2011; Zaleski eta lank., 2016). Indarra lantzeko pisu askeak zein makina gidatuen erabilera egokia dela frogatua dago (ACSM, 2009). Horrez gain, periodizazioa aurrera joan ahala ariketen zailtasuna handitzen joatea eta mugimenduaren abiadura areagotzen joatea gomendatzen da, batez ere behe gorputz-adarrak indartzeko (Gaber eta lank., 2011; de Souto Barreto eta lank., 2016).

1.5.2.2. Lan aerobikoa

Adineko pertsona osasuntsu zein gaixoetan gorputzeko gantz masa eta gaitasun kar-

diobaskular eta erresistentziaren hobekuntzari dagokionez lan aerobikoaren lanketa bitartez lortzen diren onurak frogatu dira (Montero-Fernandez eta lank., 2013). Hirugarren adineko pertsonentzat intentsitate moderatuan eguneko gutxienez 30 eta gehienez 60 minutuz jarduera fisikoa burutzea aholkatzen da. Intentsitatea altuan berriz 20 eta 30 minutu bitarte egitea gomendatzen da (Garber eta lank.,

2011). Lan aerobiko hori gutxienezko 5-10 minutuko tarteekin gauzatzea bultzatzen da, astean guztira 150-300 minutu intentsitate moderatuan edota altuan 75-100 minutu. Beraz, astean, intentsitate moderatuko 5 saio edo gehiago eta intentsitate altuko 3 saio burutzea gomendatzen da (Garber eta lank., 2011; ACSM, 2013). Intentsitatearen neurketari dagokionez, indarraren kasuan bezalaxe, 0tik 10erako eskala subjektiboan intentsitate moderatua 5-6 bitarte kokatuko litzateke eta altua berriz 7-8 artean (Nelson eta lank., 2007; Zaleski eta lank., 2016).

Hala ere, hirugarren adineko pertsona zaurgarrietan ariketa fisikoko programaren hasierako asteetan lan aerobikoa intentsitate baxuan burutzea gomendatzen da, moderaturako bidea jorratuz (de Souto Barreto eta lank., 2016; Zaleski eta lank., 2016). Lan aerobikoa ibilaldien bitartez modu jarrai batean eginda zein atsedenak tartekatuz jorratu daitekeela adierazten da (de Souto Barreto eta lank., 2016). Kontuz ibili behar da narriadura kognitiboa duten pertsonekin, intentsitate moderatua antzemateko zailtasuna dutenekin eta mina zein beste edozein arazo dutela ohartzeko gai ez direnekin. Horregatik lan aerobikoaren intentsitatea arnasketa eta bihotz taupadak igotzeko (disneak edo gehiegizko nekea ekidin) nahikoa izan behar da, gehiago ez (de Souto Barreto eta lank.,2016).

1.5.2.3. Oreka

Adineko pertsonetan erorketen prebentzioak duen garrantzia dela eta, hauskortasuna edota mugikortasun mugatua duten pertsonekin, oreka ariketa neuromotorren bitartez lantzea gomendatzen da. Entrenamendu neuromotorretan oreka, propiozepzio eta arintasun ariketak lantzen dira, eta aholkua astean 2-3 egunetan 20-30 minutu bitartea burutzea da (Garber eta lank., 2011).

Oreka ariketen intentsitatea eta progresioa definitzea zaila da (Garber eta lank., 2011), gaur egun oraindik ez baitago intentsitatea definitzen duen tresna balidaturik (Farlie eta lank., 2013). Baina periodizazioan, zailtasun maila handitzen joatea gomendatzen da (ACSM, 2013). Horretarako oinarria txikitzen joatea, grabitate-zentroa aldatzen duten ariketa dinamikoak egitea, muskuluen uzkurdura jarrerak mantentzea (adibidez puntilletan jarriz), zentzumenak murriztea (begiak itxita adibidez) (ACSM, 2009) bezalako aldaerak gehitzen joan behar da. Adibidez, zailtasuna areagotzen doan oreka estatiko (bi oinak elkarrekin, semi-tandem, tandem, hanka bakarrean) zein dinamikoa (marra baten gainetik ibil, ibiltzen goazela norabide aldaketak egin, ibilbidean oztopo argiak sahiestu eta abar) lantzea interesgarria da (de Souto Barreto eta lank.,2016). Hala ere, kontuan izan behar da oreka edota koordinazio ariketa espezifiko hauek arriskurik gabe egin ahal izateko

aurrez indarra landu den hainbat saio burutzea aholkatzen da (de Souto Barreto eta lank.,2016).

1.5.2.4. Mugikortasun artikularra edota malgutasuna

Mugikortasun artikularra (saioaren hasieran, dinamikoa da) eta luzaketa (saioaren amaieran, estatikoa da) ariketak burutzea gomendatzen da. Malgutasuna muskulua berotua dagoenean lantzea egokiagoa baita (ACSM, 2013).

Malgutasunaren entrenamendurako, luzaketak gomendatzen dira, horretarako 10-30 segundoz tenkatasun edo deserosotasun puntu batean jarrera mantendu behar da. Ariketa bakoitza 2-4 errepikapen kopuruarekin 60 bat segundo lantzea gomendatzen da (ACSM, 2013). Luzaketa estatikoak astean gutxienez 2 aldiz eta gutxienez 10 minutuz burutzea aholkatzen da (ACSM, 2013; Zaleski eta lank., 2016). Mina sentitzen dutela esateko zailtasunak dituzten pertsonekin tentuz ibili behar da (de Souto Barreto eta lank., 2016). Malgutasuna lantzea erorketen prebentziorako garrantzitsua izan daiteke, batez ere aldaka, belaun eta orkatilen mugikortasun mugatuak erorketa arriskua handitu eta ibileran izaten diren aldaketetan eragina izan dezaketeelako (Montero-Fernandez eta lank., 2013).

2.

HELBURUAK

OBJECTIVES

2. HELBURUAK / OBJECTIVES

Azken hamarkadan asko izan dira hirugarren adineko pertsonetan ariketa fisikoaren eragina aztertzen duten argitaratutako ikerketak. Hala eta guztiz ere, ikerketa gehienak komunitatean bizi diren adineko pertsonekin aurrera eraman dira eta hirugarren adineko egoitzetan bizi zein ospitalizazio bat pairatu duten bezalako biztanleri zaurgarriekin gauzatutakoak ez dira hain ugariak izan. Honi gehitu behar zaio, bereziki, osagai anitzeko ariketa fisikoko programak, funtzionaltasun fisikoaren galera ekidin edota lausotzeko eraginkorrak izan daitezkela frogatu dela. Hala ere, orain arte ez da ondorioztatu zein ariketa fisiko mota den egokiena funtzio fisiko zein kognitiboa, egoera nutrizionala edota bizi-kalitate egokia zaintzeko ospitalizazio bat bezalako egoera akutu bat izan duten hirugarren adineko pertsonentzat.

Hortaz, hau guztia kontutan harturik, ikerketa proiektu honen helburu orokorra ospitalizazio bat izan duten hirugarren adineko pertsonei lotutako parametroetan norbanakoan oinarrituriko eta intentsitate moderatuan buruturiko bi ariketa fisikoko programa progresiboen eragina aztertzea izan da.

Berariazko helburuak honakoak izaki:

1. Lehenik, adinekoek ospitaleko alta jaso ondoren ariketa fisikoko programa batean parte hartzeari uko egiteko dituzten arrazoiak identifikatzea. Bigarrenik, parte ez hartzearekin lotutako faktore fisiko, kliniko eta soziodemografikoak objektiboki aztertzea.

2. Osagai anitzeko ariketa fisikoko bi esku-hartzeren onurak alderatu, talde (gainbegiratuan ospitalean) eta bakarkako saioen (gainbegiratu gabe etxean) iraupen desberdineko aldiak zituztenak, ospitaleratu ondoren helduen funtzio fisikoari, jarduera fisikoari, bizi-kalitateari, antropometriari eta nutrizio-egoerari dagokienez.

3. Lehenik, hauskortasun eta sarkopeniarengan osagai anitzeko ariketa fisikoko bi esku-hartzeren onurak aztertu eta alderatu. Bigarrenik, hauskortasun eta sarkopeniaren irizpide bakoitzean garaturiko aldaketak aztertzea.

4. Lehenik, ospitalizazio osteko adineko helduetan miostatina eta folistatina hauskortasun eta sarkopeniaren biomarkatzaile molekular gisa hartuta, bi biomarkatzaileen arteko lotura aztertzea. Bigarrenik, bi proteinek hauskortasuna eta/edo sarkopenia identifikatzeko duten gaitasuna eta baliozkotutako proba fisiko sinpleen ahalmenarekin alderatzea.

In the last decade, many studies have been published analyzing the influence of physical exercise in the elderly. However, most of the studies have been carried out with community-dwelling elderly people and not so many have been carried out with vulnerable populations such as those who have been hospitalized or live in nursing homes. In addition, it should be added that it has been shown that multicomponent physical exercise programs can be effective in preventing or reducing the loss of physical function. However, so far it has not been concluded which type of physical exercise is the most appropriate for elderly people who have had an acute situation such as hospitalization to take care of their physical or cognitive function, their nutritional status or quality of life.

Therefore, taking all this into account, the general objective of this research project has been to analyze the influence of two individualized, progressive, moderate-intensity physical exercise programs on parameters related to elderly people who have been hospitalized.

Being specific objectives:

1. First, to identify the reasons why older people may forgo participation in a physical exercise program after hospital discharge. Second, to objectively analyze the physical, clinical and sociodemographic factors associated with non-participation.

2. To compare the benefits of two multicomponent physical exercise interventions with different time periods of group (supervision in hospital) and individual (without supervision at home) sessions in relation to physical function, physical activity, quality of life, anthropometry and nutritional status in post-hospitalized adults.

3. First, to analyze and compare the benefits of two multicomponent physical exercise interventions on frailty and sarcopenia. Second, to analyze the modifications developed in each of the criteria for frailty and sarcopenia.

4. First, considering myostatin and follistatin as molecular biomarkers of frailty and sarcopenia, to analyze the relationship between the two biomarkers in post-hospitalized adults. Second, to compared the capability of both proteins to identify frailty and/or sarcopenia with the ability of validated simple physical tests.

3.

MATERIAL ETA METODOAK

MATERIALS AND METHODS

3. MATERIAL ETA METODOAK / MATERIALS AND METHODS

3.1. Ikerketaren diseinua

Proiektu hau Osakidetzako Arabako Unibertsitate Ospitaleako (HUA) Barne Medikuntza eta Neurologia zerbitzuko eta Universidad del País Vasco/Euskal Herriko Unibertsitatearen (UPV/EHU) Ageing-On ikerketa taldearen arteko elkarlanaren fruitua izan zen. Baita ere, aipagarria da, proiektu hau Bordeleko Unibertsitatearekin (Université de Bordeaux, UB) nazioarteko tesia jorratzeko tutoretzakidetzarako hitzarmenaren barnean ezarria zegoela.

Bioaraba Osasun Ikerketa Institutuko Entsegu Kliniko eta Etika Batzordeak (CEIC-HUA Code Expte. 2017-021) eta Agente Biologikoen eta genetikoki eraldatutako organismoen Ikerketetarako Etika Batzordea (ABIEB M30/2018/201) ikerlana onartu zuten. Ikerketa proiektuaren protokoloa berriz Australian and New Zealand Clinical Trials Registry-n (ANZCTR) erregistratu zen honako kodea eskuratuz: ACTRN12619000093189. Eusko Jaurlaritzaren Hezkuntzako, Hizkuntza-Politika eta Kultura (2016111138) Departamentuko diru-laguntza batek eta Osasun Departamentuko Programa-Kontratu batek finantzatutako Ikerketa bat izan da. Horrez gain, eta azkenik, tutoretzakidetzarako hitzarmena zela eta tesia burutzeko zein estantzia Bordelen egin ahal izateko, Euskal Herriko Unibertsitateko (UPV/EHU) (PIFBUR16/07) diru-laguntza jaso dut.

Behin proiektua erregistratua zein etika batzordeak onartua izan ostean pilotuaren jorratzeari ekin genion. Honela ikerlana egiteko garaian aurretiko lana kontuan harturik prozedura egokiena erabiliko genuen. Adibidez, pilotuari eskerrak ospitalizazio ostean pazienteak intentsitate desberdineko ariketa fisikora nola egokitzen ziren erakutsi zigun eta erreklutamendua hobetzeko zein estrategia erabili beharko genituzkeen erabakitzera lagundu zigun. Azken finean, prestaturiko balorazio, saioetarako ariketak eta intentsitateak zein espazio eta materiala probatu eta doitu ziren.

3.2. Laginaren ezaugarriak

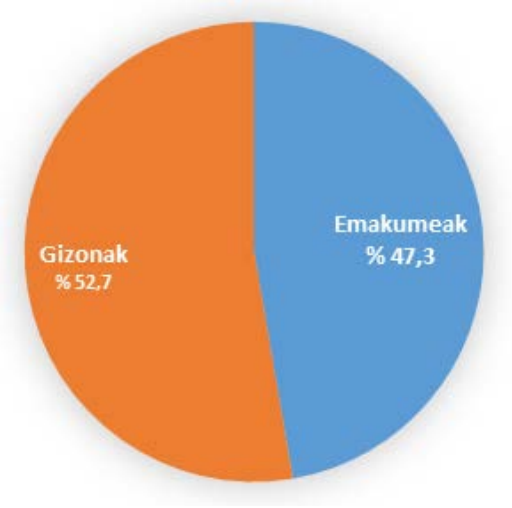
Ikerlanean parte hartu ahal izateko barneratze irizpideak honako hauek izan ziren:

- 70 urte edo gehiagoko emakume edo gizona izatea.
- Mini-Mental State Examination (MMSE) testean (Folstein eta lank., 1975) 20 puntu edo gehiago izatea.
- Bere kabuz edota laguntza gailuarekin gutxienez lau metro ibiltzeko gai izatea.

Baztertzeko irizpideak ondorengo hauek izan ziren: giltzurrunetako gaixotasun kronikoa, dementzia larria, gaixotasun neuromuskular autoimmunea, azken hiru

hilabeteetan miokardio-infartu akutua edo hezur-haustura bat diagnostikatzea, edota baimen informatuaren inprimakia sinatzeari uko egitea.

Guztira, errekrutatzeak iraun zuen denbora guztian 2.365 paziente onartu zituzten barne medikuntza eta neurologiako plantetan. Aztertu ondoren, 509 paziente hautagarri izan ziren alta emateko unean ariketa fisikoaren programari ekiteko. Ospitaleko onarpen-erregistroen arabera, hautagarri horien % 41,8 infekzioekin lotuta egon ziren, % 18,2 gaitasun motorraren narriadurarik gabeko apoplexien ondorio izan ziren, % 16,4 bihotz-gutxiegitasun deskonpentsatuaren eta % 5,5 erorikoen ondorio izan ziren. Ospitaleratzeen gainerako % 18 beste baldintza batzuen eraginez (neurologikoak, eldarnioa, anemia, etab.) izan zen. Ebaluatutako paziente horien artean, 106-k onartu zuten alta hartu orduko ariketa fisikoko programan parte hartzea. Esku-hartzea hasi aurretik, 51-k berriz ospitalizatuak izan, edo parte hartzeari uko egin zioten. Beraz, azkenik, 55 parte-hartzaile zoriz bi taldeetan banatu ziren, 28 ELA-ra eta 27 EMA-ra. Lagin osoaren batezbesteko adina 81,5 urtekoa izan zen. Parte hartu zuten pertsonetatik % 47,3 emakumezkoak eta % 52,7 gizonezkoak izan ziren.



3. Irudia: Parte-hartzaileen banaketa sexuaren arabera. **Iturria:** Propioa

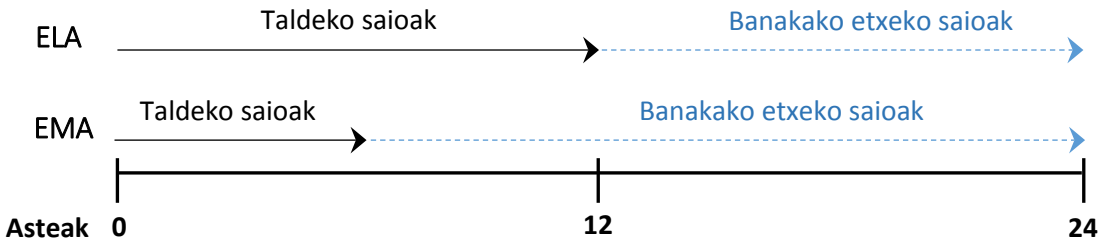
Horien % 30,4ek 12 urte edo gutxiagoko ikasketa-maila eta % 49,1ek ibiltzeko nolabaiteko laguntza erabiltzen zuten. Etxerako irisgarritasunari dagokionez, % 5,5ek etxeko sarrerarekin lotutako ingurumen-oztopoekin arazoak zituzten eta % 36,4 bakarrik bizi zen.

3.3. Prozedura eta esku-hartzea

Ikerlanean beti prozedura bera jarraituz lan egin genuen. Lehenik, errekrutatzea gauzatzeko barneratze irizpideak betetzen zituzten pazienteak identifikatu behar genituen. Horretarako egunero ospitalizazio berriak Osakidetzaren Osabide Global programan berrikusi edota plantako medikuek balizko parte-hartzaileak identifikatzen

zituzten. Bigarrenik, identifikaturiko balizko paziente horiei, beraien gelan, balorazio labur bat gauzatzen genien berauei zein familiartekoei proiektua ahoz azaldu eta baimen informatua (1. eranskina) sinatu ostean. Hirugarrenik, errekrutatze prozesua errazteko astean behin, informazio-saioak eta informazio-triptikoak ematen genituen (2. eranskina). Parte-hartzaileen onarpena izanik ospitalizazio amaieran (alta egunean) balorazio bat gauzatu, azelerometroa jarri eta 0. asteko balorazioak egiteko zita ixten genuen.

Gerora 4.irudian ikus daitekeen moduan proiektuan barneratu ziren parte-hartzaile guztietan balorazioak epe desberdinetan gauzatu ziren: esku-hartzea hasi aurretik (0 astea, alta eguna), talde luzeko fasearen amaieran (12. astea, esku-hartzearen erdian) eta esku-hartze osoaren ondoren (24. aste, amaieran). Balorazio guztiak leku berean gauzatu genituen, eta emaitza guztiak ikertzaile gaitu berak jaso zituen.



4. Irudia: Bi taldeen ibilbide eta ebaluazio asteak. **Iturria:** propioa

Ikerketa proiektu hau sei hilabeteko iraupena izan zuen ausazko entsegu kliniko bat izan da. Parte-hartzaile guztiak zoriz bi taldetan banatu ziren: epe luzeko adarra (ELA) eta epe motzeko adarra (EMA). Bi taldeen banaketa paziente guztietan 1:1 ratio banaketa errespetatuz eta generoa kontuan hartuz burutu zen. EMA-k ospitalean sei asteko talde-saioak (periodo gainbegiratua) egin zituen, eta 18 asteko banakako saioak etxean. ELA-k ospitalean 12 asteko talde-saioak (periodo gainbegiratua) egin zituen, eta beste 12 aste eman zituen etxean banakako saioak eginez.

ELA-k eta EMA-k periodo gainbegiratuan astean 60 minutuko bi saio gauzatzen zituzten, bata bestearen artean gutxienez 48 orduko epea izanik. Saio hauek, ospitalean bertan ariketa fisikoa egiteko prestatuta zegoen gela batean, heldu hauskorretan esperientziadun hezitzaile fisiko batek gainbegiratu zituen. Saio hauetan, gehienez 8 eta gutxienez 3 pertsonako taldeak parte hartzen zuten. Gelan bertan aulki sendoak, oreka zein indar ariketak burutzeko euskarri moduan erabiltzen zirenak, eta saioa burutzeko beharrezkoa zen hainbat material zeuden. Material hori, gelan bertan zegoen armairu batean gordetzen zen honako hau izanik: pisu ezberdinetako mankuernak, pisu ezberdinetako lastreak, step-ak, pilota bigunak, baloi bigunak eta konoak.

Taldekako saioetan aurrera eramaten zen entrenamendu programan, indarra, potentzia, oreka eta gaitasun aerobikoa lantzen ziren. Programa, eduki teknikoetan

autoreek aurrez antzeko populazioetan zuten esperientzian oinarrituta (Rodriguez-Larrad eta lank., 2017) eta Amerikako Kirol Medikuntza Eskola (Nelson eta lank., 2007) zein Amerikako bihotz elkarteak (Chodzko-Zajko, 2014) ezarritako gidalerroak jarraituz sortu zen. Programa hau, norbanakoari egokituta, osagai anitzeko ariketez osatua eta intentsitate arin (% 40-50) eta moderatuan (% 60-70) antolatua zegoen. Indarraren intentsitatea interbentzioan zehar % 40-50etik % 70era, progresiboki handitzen joan zen, parte-hartzaileen tolerantziaren kontuan izanik. Hasierako asteetan (1-3 asteak), helburu nagusia teknikaren ikasketa eta familiarizazioa lortzea izan zen, horretarako, aurrez esan bezala, intentsitate arinak (% 40-50) erabiliz (ACSM, 2013). Berriz, hurrengo asteetako (4-12) helburua indarraren garapena zen eta hori lortzeko intentsitate moderatuak (% 60-70) erabili ziren. Beraz, esan genezake, indar egokitzapenak finkatzeko asmoz intentsitatea bi-hiru astero behin % 5-10 igo egin zela.

Entrenamendu programaren lehen hiru asteetan, egokitzapen fasean, ariketen familiarizazioa burutzeari ekin zitzaion. Bigarren astearen ondoren, pisu gehigarriak erabiltzen hasi ziren. Lan karga hori zehazteko, Brzycki ekuazioaren (Brzycki, 1993) bitartez errepikapen maximoaren (RM1) estimazio testa egin zen. Ondorengo asteetan, alegia 6. asterarte EMA-n eta 12. astearte ELA-n, bolumena eta intentsitatea progresiboki aurrez programatua zegoen bezala handitzen joan zitzaien.

$$\text{Brzycki ekuazioa} = \text{Pisua} \div [\, 1.0278 - (\, 0.0278 \times \text{Errepikapen kopurua}) \,]$$

Atal gainbegiratuan eginiko programa honelako egitura zuten saioez osatua zegoen:

Saioen hasieran 5-10 minutuko girotze aldi labur bat gauzatzen zen. Non, lepo, sorbalda, eskumutur, aldaka, belaun eta orkatilen mugikortasun artikularra lantzeko ariketak egiten ziren.

Atal nagusian indar, oreka zein gaitasun aerobikoa lantzen zen 30-40 minutuz. Indar entrenamenduan, goi zein behe adarrak lantzeko (beso-flexioa, belaun luzatze eta tolestea, aldaka luzatze, hanka abdukzio, oin eta orpo altxatze eta altxa-eseri) ariketak material zein pisu gehigarriarekin egiten ziren. Hauen intentsitateak lehen 3 asteetan RM1-etik % 40-50 ziren eta gainontzekoetan RM1-etik % 60-70 bitartekoak. Oreka entrenamenduari dagokionez, oreka estatiko zein dinamikoa lantzeko ariketak gauzatzen ziren. Hauen zailtasunak progresiboki esku euskarriak eta sostengu oinarriak txikituz edo kenduz eta mugimendu konplexuak gehituz garatu ziren. Alegia, oreka lantzeko ariketen kasuan, ariketa estatikoetatik hasita, ariketa dinamikoak sartuz mugimenduen konplexutasuna progresiboki handitzen joan zen. Lan aerobikoa gauzatzerako orduan zegoen espazio murritza zela eta, 10 edo 60m-ko itzuliak besterik ez ziren egiten. Hala ere, beti, saioetatik at ibiltzeko gomendatzen zitzaien.

Saioa amaitzeko, lasaitze zein erlaxazio aldi bat gauzatzen zen. Bertan, malgutasun ariketa bat aurrera eraman eta jarraian arnaste sakonen bitartez, erlaxazioa bilatzen zen.

Bertaratzeak saio guztietan jasotzen ziren horretarako sortutako Excel orri batean. Saio bat egina hartzen zen, ariketen % 80 edo gehiago eginez gero. 3. eranskinean atal gainbegiratuan eginiko saioen antolaketa eta ariketei buruzko informazio gehigarria ikusgai dago. Baita ere eranskin berean parte-hartzaile bakoitzari saioen kontrola eramateko egutegi adibide (6 astekoa) bat ageri da.

EMA-k eta ELA-k etxean gauzatu behar zuen programa, baita ere autoreek duten esperientzian oinarritzeaz gain, Otawa Exercise Programme (Campbell eta lank., 2003) eta European Vivifrail proiektuetan (Izquierdo eta lank., 2017) oinarritzen zen. Kasu honetan indarra, oreka (beti beste bizikide bat ondoan zutela) eta gaitasun aerobikoa lantzeko helburuarekin parte-hartzaile bakoitzari astekari bat (4. Eranskina) eman zitzaion. Bertan ariketa anitzeko bost saio eta gaitasun aerobikoa paseoen bitartez lantzeko 7 eguneko gomendioak agertzen ziren. Saio horiek beti atal gainbegiratuan landutako ariketaz osatuak zeuden eta ibiltzeko gomendio horiek 6 minutu ibiltzen testean oinarrituak zeuden. Gomendio horiek, programaren hasieran 15 minutu eguneko izatetik, bukaeran 45-60 minutu izatera pasa zitezkeen. Material gehigarria zuten partaideei intentsitate moderatuan (% 60) erabili beharreko pisua erabiltzeko adierazten zitzaien. Bestalde ariketak etxean zuten material zein bakoitzaren gorputz pisuarekin gauzatzeko pentsatuak zeuden.

Partaideek bi astetik behin telefono dei bat jasotzen zuten beraien zalantzak argitu eta ariketa zein paseoekiko atxikimendua jasotzeko asmoz. Kasu honetan, saioaren % 50a edo gehiago jorratuz gero, saioa egintzat ematen zen. 5. eranskinean bakarkako saioen ariketa sorta eta ibiltzeko gomendioei buruzko informazio gehigarria ikusgai dago.

3.4. Balorazioak

Balorazioak aukeratzerako garaian kontuan izan genuen, nola ez, test edo eskala balioztatu zein fidagarriak eta ahal bagenu eskala jarraiak dituzten test multzoak izatea. Prozeduran azaldutako pausuak kontuan izanik eta proiektu osoa gauzatuz gero parte-hartzaile guztiek bost balorazio epe desberdin izan zituzten (errekrutatzea, alta eguna eta 0.astea, 12. astea eta 24. astea), horretarako 6. eranskinean ikus daitekeen bezala hiru erregistro orri desberdin sortu genituen. Ikasketa prozesuaren ondorioz izandako hobekuntzak ekiditeko proba guztiak birritan gauzatu zituzten eta bietatik hoberena hautatu zen.

Neurketa guztiak ospitalean bertan egin ziren, aurretik aipatu bezala, lehenik bakoitzaren gelan eta gerora proiekturako zoriz banatu ostean horretarako espresuki

ospitaleak eskainitako eta moldatutako kontsultan. Bertan egoera fisikoko proba gehienak, hauskortasuna, gorputz-osaeraren neurketak, odol-ateratzeak, eta test neuropsikologikoak burutu ziren. Aldiz, ibilera abiadurako ohiko zein azkarreko probak eta 6 minutuko proba kontsulta zegoen hirugarren solairuko korridorean burutu genituen. Ondorengo lerroetan, proba hauek burutzeko erabilitako materiala zein prozedurak deskribatuko dira. Egoera zein jarduera fisikoa eta bizi-kalitatea neurtzeko erabilitako prozedurak deskribatuz hasiz. Ondoren, gorputz-osaera, nutrizio-egoera eta odol analisiak aztertzeko erabilitako prozedurekin jarraituz. Eta azkenik, ikerketa honetan erabilitako hauskortasuna, funtzio kognitiboa zein afektibitate-egoera neurtzeko erabili diren testekin bukatuz.

3.4.1. Egoera fisikoa

3.4.1.1. Short Physical Performance Battery (SPPB)

SPPB-a hirugarren adineko pertsonen behe gorputz-adarren funtzioa objektiboki neurtzeko helburua duen test multzo laburra da. Test multzo hau gaur egun hirugarren adineko pertsonen gaitasun fisikoak neurtzeko erreminta erabilienetakoa da. Guralnik eta lankideek 2000. urtean garatu zuten. Test multzo honek fidagarritasun oso altua dauka. Gaitasun funtzionaleko aldaketak zein desgaitasun-arriskua antzemateko sentikortasuna frogatua du. Alegia, “screening”-erako tresna baliagarria da, ospitaleko alta jaso ondoren emaitza txarrak lortzeko arrisku handia duten adinekoak identifikatzeko egokia izateaz gain. SPPB-ko puntuazio altuenek funtzio edo egoera fisiko hobea adierazten dute eta puntuazio txarrak ordea erorketa, eguneroko jarduerak burutzeko zailtasun, mugikortasun galera, desgaitasun, ospitalizazio, instituzionalizazio eta heriotzarekin lotu dira (Guralnik eta lank., 2000; Volpato eta lank., 2011).

SPPB-ak, orekaren ebaluazioa, ibileraren abiadura eta beheko gorputz-adarren indarra uztartzen ditu. Ebaluazioa ere hurrenkera horretan gauzatu behar da. Proba bakoitza 0-4ko eskalan kalifikatzen da, errendimendu osoaren puntuazio-tartea 0-12 puntukoa izanik (Guralnik eta lank., 2000). Erabilitako materiala honakoa izan zen: besaurrerik gabeko aulkia, kronometroa, zinta itsaskorra eta distantziak neurtzeko zinta metrikoa (20 m).

Oreka estatikoa:

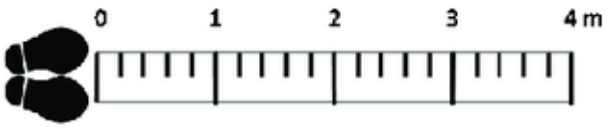
Parte-hartzaileari hiru posiziotan 10 segundoz mantentzen saiatzeko eskatuko zitzaion: bi oinak elkarrekin, semi-tandem eta tandem posizioan. Atal honetan, lehenengo posizioa gauzatu ahal izanez gero, hurrengoa burutzen zen, baina posizioa mantendu ezin baitzuen, ez zen hurrengo posizioa burutzen.

5. Irudia: SPPB-ko oreka estatikoaren hiru posizioak. **Iturria:** Guralnik eta lank., 2000.

Puntuazioak: Parte-hartzaileak ez zuen punturik jasotzen 10 segundoz oinak elkartuta oreka mantentzeko gai ez bazen. Lortuz gero puntu bat ematen zitzaion, bi puntu semi-tandem posizioan mantentzagatik, hiru puntu tandem posizioan 3-9,99 segundoz mantenduz gero eta lau puntu tandem posizioan 10 segundoz oreka mantentzea lortzen bazuen. Beraz, puntuazio altuenak oreka estatiko hobea adierazten du.

Ibilera abiadura:

Parte-hartzaileari ohiko erritmoan lau metroko distantzia ibiltzeko eskatu zitzaion. Behar izango balu, parte-hartzaileak laguntza tresna (makulua, eskorga, bastoi...) erabili zezakeen. Parte-hartzaileak ibiltzeari ekiten zionean denbora neurtzen hasten zen eta berriz lau metroak igaro ostean denbora gelditzen zen. Atal hau bi aldiz burutu zuten eta bi aldietako denborarik onena hartu zen kontuan.



6. Irudia: SPPB-ko 4 metroko ibilera abiadura. **Iturria:** Guralnik eta lank., 2000.

Puntuazioak: Parte hartzaileak ez zuen punturik jasotzen lau metro oinez ibiltzeko gai ez bazen. Puntu bat jasotzen zuen 8,7 segundo edo gehiago behar izanez gero, bi puntu 6,21-8,79 segundo bitarte behar bazituen, hiru puntu 4,82-6,20 segundo bitarte behar izanez gero eta lau puntu 4,82 segundo baino gutxiago erabiltzen bazituen. Beraz puntuazio altuak ibilera abiadura azkarra adierazten du.

Altxa eta eseri:

Parte-hartzaileak aulkitik bost aldiz altxa eta esertzeko behar duen denbora jaso zen. Horretarako parte-hartzaileari proba hau besoak gurutzatuta mantentzeko eta ahalik eta azkarren egiten saiatzeko adierazi zitzaion. Errepikapen bat modu egokian gauzatzeko gai zela ziurtatu ostean, testa burutzeari ekiten zitzaion. Parte-hartzaileak aulkitik altxatzeari ekiten zionean denbora kontatzen hasten zen eta bosgarren aldiz guztiz altxatzean (zutik) denbora gelditzen zen. Proba bertan behera geratzen zen parte hartzaileak altxatzeko eskuak erabili edota minutu bat baino gehiago behar izanez gero.

7 Irudia: SPPB-ko 5 altxaldiak. **Iturria:** Guralnik eta lank., 2000.

Puntuazioak: Parte hartzaileak ez zuen punturik jasotzen minutu batean aulkitik bost aldiz altxatzeko gai ez bazen. Puntu bat jasotzen zuen 16,7 segundo baino gehiago behar baitzituen, bi puntu 13,70-16,69 segundo bitarte behar bazituen, hiru puntu 11,20-13,69 segundo bitarte behar izanez gero eta lau puntu 11,19 segundo baino gutxiago erabiltzen bazituen. Beraz, puntuazio altuak beheko gorputz-adarren indar handiagoa adierazten du.

3.4.1.2. Eskuko eta besaurreko indarra

Eskuko eta besaurreko indarra, osasunarekin lotuta dagoela frogatu da, zehazki, gaixotasun kardiobaskular, desgaitasun, morbilitate eta heriotzarekin Leong eta lank., 2015; Sayer eta Kirkwood, 2015). Horrez gain, esku eta besaurreko indarrak hirugarren adinean galera fisiko zein kognitiboa ebaluatzeko iragarpen balio moduan onartua dago (Rijk eta lank., 2016). Hala ere, ikerketa gehiagoren beharra azpimarratu dute eskuko eta besaurreko indarraren handitzeak zein eragin izan dezakeen ondorioztatzeko (Leong eta lank., 2015).

8. Irudia: Eskuko eta besaurreko indarraren neurketa. **Iturria:** Propioa

Parte-hartzailea besaurrerik gabeko aulki batean eserita egonik dinamometroa eskuarekin nola hartu behar zuen azaltzen zitzaion. Hots, dinamometroa eskuarekin eustean erdiko falangeekin indarra egin behar zuela eta ukondoa 90º-tara tolesturik zuela ahalik eta gehien estutzeko esan zitzaion. Proban parte-hartzaileek esku banarekin (dominantea zein ez-dominantea) bi saiakera burutu zituzten. Dinamometro digitala kilogramoetan (kg-tan) ezarria zegoen eta esku bakoitzeko

neurketarik hoberena (indar maximoa) hautatzen zen. Erabilitako materiala honakoa izan zen: Patterson Jamar Plus (Jamar, IL, USA) dinamometro digitala eta besaurrerik gabeko aulkia.

3.4.1.3. Senior Fitness Test (SFT)

SFT-a adineko pertsonen egoera fisikoa modu seguru eta praktikoan aztertzeko 2001ean Rikli eta Jones-ek, sorturiko test multzoa da. Test multzo honek zapi atalek osatzen dute, batera uztartu edo banaka erabili daitezkeenak. Gure kasuan atalak banaka erabiltzea erabaki genuen eta zazpi atal horietatik jarraian sakonago azalduko ditudan lau erabili genituen. SFT-a 60-94 urte bitarteko pertsona autonomo zein gaitasun fisiko eta funtzional desberdineko pertsonentzako egokia da. Gainera, test multzoak ematen dituen erreferentzia-baloreei esker (generoka eta bost urteko tarteak) ikerturiko parte-hartzaileen adin eta sexu bereko balore normalekin konpara ditzakegu (Rikli eta Jones, 2001). Erabilitako materiala honakoa izan zen: besaurrerik gabeko aulkia, kronometroa, emakumeentzat bost librako (2,27 kg) eta gizonentzat zortzi librakoa (3,63 kg) neoprenozko Valeo HW5 mankuernak, zinta itsaskorra, distantziak neurtzeko zinta metrikoa (20 m), distantziak mugatzeko konoak, eta Polar ft4 (Finlandia) pultsometroa.

Altxa eta eseri (30 segundotan): 30-s Chair-Stand Test

Atal honetan behe adarreko indarra (aulkitik altxatzeko gaitasuna) ebaluatu zen. Parte-hartzaileak bizkarra zuzen, oinak lurrean eta besoak bularrean gurutzatuta zituelarik besaurrerik gabeko aulkian eserita egon behar zen. Parte-hartzaileak eskuak gurutzatuta mantenduz, aulkitik altxatzeari ekin eta hasierako jarrerara bueltatu behar zen. Ekintza hori 30 segundotan ahal bezain bestetan errepikatu behar zuen. Proba ahoz garbi azaltzeaz gain, aulkia paretaren kontra jartzea eta ebaluatzailea parte-hartzailearen ondoan kokatzea komenigarria zen, desoreka edo erorketa arriskua ekiditeko. Parte-hartzaileari mugimendua probatzeko aukera ematen zitzaion.

Puntuazioa: Parte-hartzaileek 30 segundotan buruturiko altxa-eseri errepikapen kopurua jaso zen. Denbora amaitutakoan parte hartzaileak mugimenduaren erdia (zutik) edo gehiago burutu balu, errepikapen hori ontzat kontatzen zen. Bi saiakeretatik errepikapen gehien (kopuru maximoa) burutu zuen proba kontuan hartzen zen. Errepikapen kopuru handiak beheko gorputz-adarren indar handia adierazten du.

Beso-flexioa (30 segundotan): 30-s Arm-Curl Test

Atal honetan goi adarreko indarra ebaluatu zen. Parte-hartzailea paretaren kontra

kokaturiko aulkiaren erdialdean, bizkarra zuzen eta oinak lurrean jarrita zituelarik kokatzen zen. Emakumea izanez gero 2,27 kg-ko pisua erabiltzen zuen, gizonekin berriz 3,63 kg-koa. Proba beso eta esku dominantean gauzatu zen. Parte-hartzailea aurretiaz azalduriko posizioan egonik, pisua ongi ebaturik zuela, esku ahurra gorputzari begira jarri behar zuen hasierako posizioa osatuz. Horrela egonik, probari ekiten zion, pisua altxatzen hasi bezain pronto eskumuturra biratu behar zuen esku ahurra gora begira geratu arte. Ukondoaren flexioa, ahal izanez gero, pisua sorbaldaren altuerara igo arte egin behar zuen. Behin pisua igo ondoren, eskua hasierako puntura jaitsi behar zuen besoa luzatuaz eta eskumuturra aurreko posizio berera biratuz. Parte-hartzaileari ahoz mugimendu oso hau 30 segundoz ahal bezain bestetan errepikatzeko azaldu zitzaion. Ekintza nola egin garbi azaltzeaz gain, ebaluatzaileak parte-hartzailearen ondoan kokatzea komenigarria zen. Honela, probaren gauzatze egokirako parte-hartzaileak pisua igo zein jaisterakoan ukondoa mugitzen ez zuela ziurtatu eta pisua igo edo jaisterakoan sorbalda zein izterrean kolpeak ekiditeko. Parte-hartzaileari mugimendua probatzeko aukera ematen zitzaion.

Puntuazioa: Parte-hartzaileek 30 segundotan buruturiko altxaldi kopurua jasotzen zen. Denbora amaitutakoan parte hartzaileak mugimenduaren erdia (flexioa) edo gehiago burutu bazuen, errepikapen hori ontzat kontatzen zen. Bi saiakeretatik errepikapen gehien (kopuru maximoa) burutzen zena hartzen zen kontuan. Errepikapen kopuru handiak goiko gorputz-adarren indar handia adierazten du.

Sei minutuko proba (ibiltzen): 6-minute Walking Test

Atal honetan gaitasun aerobikoa edo erresistentzia ebaluatzen zen. Proba hau burutu ahal izateko leku zabal baten beharra dago, 4,57 x 18,38 metrokoa zehazki. Hori Santiago ospitalean gauza gaitza zenez, 6 minutuko proba, 30 metro luzerako espazioa beharrezkoa den aldaeran gauzatu zen. Beraz, proba 30 metro baino luzeagoa zen korridorea erabiliz egin zen. Bertan garrantzitsua izan zen zoru lau eta ez irristakorra izatea eta baita ere proba gauzatzen zen bitartean jendearen fluxua kontrolatzea. Aurrez, zinta itsaskorrarekin, ibilbidearen hasiera eta bukaera zein biraketak gauzatu behar ziren puntuak markatu ziren. Ibilbideak guztira 30 metroko luzera zuen eta kono bakoitzaren artean 29 metro zeuden. Mutur bakoitza eta bira eman behar zen konoaren artea 0,5 metroko distantzia zegoen norabide aldaketa (biraketa) segurtasunez egin ahal izateko. Parte-hartzaileari ahoz, 6 minututan zehar gauzatu beharreko ibilbidea (itzulia) ahal bezain bestetan errepikatzeko azaldu zitzaion. Proba nola egin garbi azaltzeaz gain, ebaluatzailea uneoro parte-hartzailearen ondoan kokatzea komenigarria zen. Alde batetik, parte-hartzaileak zenbat itzuli eman zituen eta bihotz maiztasuna kontrolatzen joateko. Itzuli

bakoitzeko denbora ere jasotzen zen. Eta beste alde batetik, hiru, lau eta bost minutuetan, parte-hartzaileari falta zen denbora adierazteko, azken honek ibilera abiadura kontrola zezan, proba ahalik eta azkarren ibiltzen egin behar baitzen. Sei minutuak igarotzean, parte-hartzaileari zegoen tokian geratzeko esaten zitzaion minutu bateko errekuperazioa egin zezan. Proba gauzatzeko beti bi ebaluatzaile zeuden, aurrez esan bezala jende fluxua kontrolatzeko eta parte-hartzailea gehiegi nekatzen bazen, berehala aulki bat gerturatu ahal izateko gerora atseden hartu ostean berriz ibiltzeari ekin edo proba amai zezan. Nahiz eta proba hau gauzatzeko ez zen beharrezkotzat jotzen, segurtasun neurri moduan, bihotz maiztasunaren kontrola eramateko pultsometroak erabili ziren. Baita ere, hasierako zein bukaerako bihotz maiztasunak eta Borg eskalaren (Borg, 1970) bitartez esfortzu kardiobaskular eta muskularra neurtu ziren.

Puntuazioa: Parte-hartzaileak 6 minututan eginiko distantzia totala (metrotan) kontuan hartu zen. Horretarako itzuli kopurua (60 metro) eta azken itzulian eginiko metroak batzen ziren. Itzuli kopuru handiak gaitasun aerobiko edo erresistentzia egokia adierazten du.

Altxa, ibili, bira eta eseri (2,44 metro): 8-Foot Timed Up and Go Test

Atal honetan oreka dinamikoa eta zalutasuna ebaluatzen ziren. Proba hau burutu ahal izateko aulki bat paretaren kontra kokatua zegoelarik, 2,44 metrotara kono bat ipini zen. Distantzia hori, aulkiaren aurreko ertzetik konoaren atzeko alboko distantzia zen. Proba ahalik eta azkarren egin behar zuten. Alegia, parte-hartzailea zutitu, konoraino ibiltzen joan, konoa inguratuz bira emanez norabidea aldatu eta berriz aulkian eseri behar zen. Parte-hartzaileak bizkarra zuzen, oinak lurrean eta besoak bularrean gurutzatuta edo eskuak izterretan zituelarik besaurrerik gabeko aulkiaren erdialdean eserita egon behar zen. Hasi aurretik, parte-hartzaileak gorputza pixka bat aurrealderantz inklinatu eta oin bat bestea baino aurrerago ipintzen zuen, ateratzeko prest egongo balitz bezala. Parte-hartzaileari testa ahoz azaltzeaz gain, erakustaldi bat egiten zitzaion zalantzan argitu asmoz. Ebaluatzailea proba burutzen zebilenaren ondoan joaten zen, honek oreka galduz gero erortzeko arriskua eteteko.

Puntuazioa: Parte-hartzaileak proba osatzeko erabilitako denbora (segundoetan) hartzen zen kontuan. Denbora parte-hartzaileak altxaldia ekiterakoan hasten zen kontatzen eta bukatu berriz aulkian esertzerakoan. Bi saiakeretatik denbora gutxien behar izan zuen probaren denbora jasotzen zen. Denbora gutxi behar izateak oreka dinamiko edota zalutasun hobea adierazten du.

3.4.1.4. Ibilera abiadura

Gaitasun funtzionalaren gainbehera gehienbat ibiltzeko gaitasunaren okertzeak dakar. Ibilera abiadura hirugarren adineko pertsonetan gaitasun funtzionalaren gainbehera antzemateko erabiltzen den ohiko test bat da (Cesari eta lank., 2005; Rosano eta lank., 2008; Cesari eta lank., 2009; Studenski eta lank., 2011). Komunitatean bizi diren adinduen ohiko ibilera abiadura < 1 m/s-koa dutenetan, osasunari loturiko ondorio kaltegarriak izateko arriskuan daudela frogatu da; hala nola hilkortasuna eta ospitalizazioak iragartzen ditu (Guralnik eta lank., 2000; Cesari eta lank., 2005). 0.8 m/s-ko ibilera abiadura hauskortasun-markagailu gorte-puntu bezala kontuan izateaz gain, abiadura horren beherako baloreak osasun egoera patologikoekin ere erlazionatzen dira (Montero-Odasso eta lank., 2004; Cruz-Jentoft eta lank., 2010; Studenski eta lank., 2011). Erabilitako materiala honakoa izan zen: kronometroa, zinta itsaskorra eta distantziak neurtzeko zinta metrikoa (20 m).

Parte-hartzaileak 10 metro ibili behar izan zituen, abiadura arruntean zein azkarrean gauzatzen zuten. Aldaera bakoitza birritan gauzatu zuten. Ibilbidean nahiz eta 10 metrokoa izan, denbora 4 edo 8 metro gauzatzeko behar izan zutena jaso zen. (Bohannon eta lank., 1996) Hasierako fasea, alegia, 1.go metroa eta azkenengo fasea, azken metroa, neurketatik kanpo utzi zen, azelerazioa zein dezelerazioa baitziren. Bi saiakeretatik parte-hartzaileak denbora gutxien behar izan zuen denbora jaso eta distantziarekin zatituz, ibilera abiadura kalkulatu zen.

3.4.1.5. Berg Oreka Eskala

Berg Balance Scale balioztaturik dagoen, 14 proba dituen eta oreka galera antzemateko gai den oreka test multzo bat da (Berg eta lank., 1992). Berg oreka test multzoak erorketak izango ez dituen pertsona aurreikusteko baliogarria dela frogatu da, nahiz eta ez den oraindik testeko puntuazioaren eta erorketa kopuruarekin lotura zuzenik frogatu (Bogle-Thorbahn eta Newton, 1996). Test multzoa gauzatzeko erabilitako materiala honakoa izan zen: besaurrerik gabeko aulkia, besaurredun aulkia, kronometroa, zinta itsaskorra, paretan itsasteko paperezko zinta metrikoa, step bat eta kono bat.

Esan bezala test multzo honek 14 proba desberdin ditu. Proba bakoitzean, parte-hartzaileari ahoz azaldu ostean demostrazio praktiko bat egiten zitzaion. Proba bakoitzak puntuazio zehatz bat du, 0 eta 4 bitartekoa izan daitekeena. Proba guztietako puntuak gehitu ziren puntuazio orokor bat izateko. Beraz puntuazioa baxuena 0 izan zitekeen eta altuena berriz 56. Puntuazio altuak oreka estatiko egokia adierazten du.

3.4.2. Jarduera edo aktibitate fisikoa

Osasun arloko ikerketak burutu eta osasun-egoera mantentzeko egokiak diren aholkuak helarazi ahal izateko jarduera fisikoaren neurketa jorratzea garrantzitsua da (Troiano eta lank., 2008; Bernard eta lank., 2018). Azelerometroen erabilpenarekin neurketa objektiboak egiteko gaitasuna dugu. Hauen bitartez jarduera fisikoaren kantitatea, maiztasuna, iraupena eta intentsitateari buruzko informazioaz gain denbora sedentarioa edota atseden denbora (loa) jaso daiteke (Migueles eta lank., 2017). Azelerometroa gerrian eta eskumuturrean jarri daiteke, baina gerrian jartzean emaitza zehatzagoak lortzen direla dirudi. Hala ere, gaur egun pertsona adinduetan eskumuturreko azelerometroekin jarduera fisikoa zein loa aztertu duten ikerketa gutxi daude (Migueles eta lank., 2017). Erabilitako materiala honakoa izan zen: wGT3XBT Actigraph azelerometroa, Actigraph konpainiako ActiLife analisi softwarea (6.11.9 bertsioa. Actigraph LLC, Pensacola, FL, USA) eta lo zein dutxa orduak apuntatzeko astekaria.

Beraz parte-hartzaileen eguneroko tarte aktibo eta sedentarioak zein loa azelerometro bitartez jaso ziren. Parte-hartzaile bakoitzak gerriko baten bitartez gerriaren eskuin aldean lotuta azelerometro bat eraman zuten.. Azelerometroa eraman zuten astebeteetan ez zuten jarduera fisikoa burutzeko jarraibiderik jaso. Parte-hartzaileari zein bere senideei ahoz azelerometroa nola jantzi eta erantzi eta astekaria nola bete behar zen azaltzeaz gain, erakustaldi bat egiten zitzaien zalantzak argitu asmoz. Baita ere, dutxatzeko edo uretako jarduerak egiteko garaian zein lo egiterakoan (gabean edo siesta ohean) gerrikoa kendu eta esnatzerakoan berriz jartzeko adierazi zitzaien. Horrez gain, parte-hartzaile bakoitzari edo beraien senideei informazio orria zein beraien erregistro paper (7. eranskina) bat eman zitzaien.

Azelerometroen datuen analisia gauzatzerakoan, soilik gutxienez hiru egun baliagarri zituzten parte-hartzaileen erregistroak kontuan hartu ziren. Egun bat baliagarria izateko parte-hartzaileek 10 ordu baino gehiagoko aktibitatea izan behar zuten (Hart eta lank., 2011). Baldintza hauek betetzen ez zituzten erregistroak ez ziren aztertu. Horrez gain, adierazi ikerketa honetan Freedson, Melanson eta Sirard-ek 1998an sorturiko ebaki-puntuak hautatu genituela.
Ebaki-puntuak honako hauek dira:

- Jarduera sedentarioa: < 100 kontu/minutu
- Jarduera arina: 100 - 1951 kontu/minutu bitarte
- Jarduera ertaina: 1952 - 5724 kontu/minutu bitarte
- Jarduera kementsua: 5725 - 9498 kontu/minutu bitarte
- Jarduera oso kementsua: > 9499 kontu/minutu

3.4.3. Bizi-kalitatea

Parte-hartzaileei EuroQol–5 Dimension (EQ-5D) eskalako bertsio Espainiarra pasa genien (Badia, eta lank., 1999). EQ-5D, EuroQol taldeak garatua (www.euroqol.org), osasunarekin lotutako bizi-kalitatea deskribatu eta baloratzeko tresna generiko eta estandarizatua da. Tresna honek bi zati nagusi ditu: EQ-5D sistema deskribatzailea eta Eskala Bisual Analogikoa (EBA). EQ-5D sistema deskribatzaileak 5 dimentsio ditu: mugikortasuna, autozainketa, ohiko jarduerak, mina/ondoeza eta antsietatea/depresioa. Dimentsio bakoitzean 5 erantzun-aukera izanik. EBA-n parte-hartzaileak osasuna bi muturren artean puntuatu behar du, 0 eta 100, alegia, imajina daitekeen osasun-egoera oker eta hobeenaren artean.

Adineko pertsonek galdeketak osatzeko izaten dituzten arazoak, hala nola galdeketa ez ulertu, ongi irakurri edo galderak zuriz uztea, kontuan hartu genituen eta 8. eranskina aurrean izanik elkarrizketa bidez egitea erabaki genuen. Erabilitako materiala honakoa izan zen: eskala inprimaturiko folio bat, bolaluma bat eta behar zuenak irakurtzeko betaurrekoak.

3.4.4. Gorputz-osaera

3.4.4.1. Egoera Nutrizionala

Orokorrean, komunitatean bizi diren adineko pertsonen desnutrizio-prebalentzia baxua izan arren, desnutrizio arriskua asko handitzen da ospitalizatutako edo instituzionalizatutako pertsonetan (Guigoz eta lank., 1996). Malnutrizioa, erreferentziazko parametroak kontuan hartuz, gorputz-osaeraren asaldura gertatzen den koadro klinikotzat definitzen da eta orokorrean elikagaien ahoratzearen, horien aprobetxamenduaren eta pertsonaren elikadura beharren arteko desoreka batek eragindakoa izaten da (Elia eta Stratton, 2004).

Egoera nutrizionala Mini Nutritional Assessment (MNA) probaren bidez ebaluatu zen. Parte-hartzaileak eta/edo haren senide edo zaintzaileak osatu zuten proba. Senide edo zaintzaileek ezin bazuten galdeketa aurrean izan, elkarrizketa bidez egitea erabaki genuen. Galdeketa honek 18 item ditu, lau kategoriatan banatuak: ebaluazio antropometrikoa, ebaluazio orokorra, ebaluazio dietetiko laburra eta ebaluazio subjektiboa. Erantzun bakoitzak zenbakizko balio bat du, azken puntuaziorako batzen direnak. Gehienez ere 30 puntu lor daitezke. 24 puntutik 30era bitarteko puntuazioek nutrizio egoera normala islatzen dute, 17tik 23.5 puntuazioek desnutrizio arriskua adierazten dute eta 17tik beherako puntuazioak desnutrizioa adierazten du (Guigoz eta lank., 2002).

Ospitalizazioan zehar, alegia, erreklutamendua gauzatzerakoan egoera nutrizionala neurtzeko MNA-ren forma laburra (MNA-SF) erabili zen. MNA-SF detekzio-tresna

baliozkotua da, eta forma luzea bezala Nestle-k diseinatua desnutrizio-arriskuan dauden adineko pertsonak identifikatzeko. Probak 5 galdera (jateko gogoa edo elikatze-arazoa, berriki pisua galtzea, mugikortasuna galera, gaixotasun akutua/estresa, dementzia edo depresioa) eta neurketa antropometriko batek (biki-zirkunferentzia neurtzea) osatzen dute. Biki-zirkunferentzia pazientea eserita, oinak lurrean pausatuta, eta belaunak 90º-ra tolestuta zegoela neurtu zen. Gehienez ere proban 14 puntu lor daitezke, eta 12 puntu baino gutxiago lortuz gero, desnutrizioa egon daitekeela adierazten du (Kaiser eta lank., 2009).

Erabilitako materiala honakoa izan zen: bi galdeketak inprimaturiko folio bana, bolaluma bat, CESCORF zinta antropometriko ez-elastikoa eta behar zuenak irakurtzeko betaurrekoak.

3.4.4.2. Antropometria

Parte-hartzaile baten pisuaren eta egitura fisikoaren arteko oreka egokia den ezagutzeko antropometriaren balorazioa baliagarria da. Metodo hau ez da mingarria ezta erasokorra ere. Horrez gain, nahiz eta gurea lagina oso handia ez izan, munduan eginiko ikerketen erreferentziazko neurriekin alderatzea ahalbidetzen duten osasun egoeraren adierazlea egokiak dira (Marfell-Jones eta lank., 2012).

Antropometria-neurketak ebaluazio funtzionalak egin aurretik egin ziren, beraz, neurketa funtzionalak bezala, hiru une desberdinetan egin zitzaizkien. Proba antropometrikoetan eskarmentu handiko eta nazioarteko ziurtagiria (ISAK 1. maila) zuen nutrizionista batek gauzatu zituen. Beti ere, International Society for the Advancement of Kineanthropometry-ren (ISAK) protokoloak dioen bezala burutu ziren neurketa antropometrikoak (Marfell-Jones eta lank., 2012).

Azterturiko parametro antropometrikoak honakoak izan ziren:

- Pisua: Protokolo estandarrei jarraituz, alegia, parte-hartzaileek oinetakoak eta arropa sendoena kendu, zutik eta geldirik plataformaren erdian kokatu eta gorputzaren pisua bi oinetan banatuta neurtu zen bakoitzaren pisua. Omron HN288 balantza digitala erabili zen neurtzeko. Berau, 0 eta 180 kg-ko balio-tartea eta 100 g-ko zehaztasunez kalibratutako balantza digitala da.
- Altuera: Parte-hartzaileen altuera estimazioaren bitartez kalkulatzeko belaunaren altueraren neurketaren formula erabili zen (Chumlea eta lank., 1985).

Gizon ♂	(2,02 x *belaunaren altuera*) - (0,04 x *adina*) + 64,19
Emakume ♀	(1,83 x *belaunaren altuera*) - (0,24 x *adina*) + 84,88

Horretarako Seca 213 tallimetroaz (cm-tan, mm 1eko zehaztasunez) baliatu ginen. Parte-hartzaileak oinetakorik gabe oinak lurrean ondo ezarriak zituztela, besoak gorputzarekiko paralelo eta belaunak 90º tolesturik zituztela aulki batean eserita egon behar ziren.

- Gorputz-masaren indizea (GMI): GMI, pisua (kg) eta altueraren (m) arteko erlazioa da eta bi parametro hauen bidez honela kalkulatzen da:

$$GMI = \frac{\text{Pisua (kg)}}{[\text{Altuera (m)}]^2}$$

- Gorputz-adarretako perimetroak zinta metriko ez-elastiko (CESCORF) batekin neurtu (cm) ziren:
  - Besoko perimetroa: Muskuluaren uzkurtzerik gabe.
  - Gerriaren perimetroa: Hau neurtzeko zilborra erreferentziatzat hartu zen. Neurketa parte-hartzailea zutik eta besoak erlaxatuta zituela egin zen.
  - Aldakaren perimetroa: Hau neurtzeko ipurmasailen punturik irtenena erreferentziatzat hartu zen. Neurketak egiterakoan parte-hartzaileei ipurmasailak ez estutzeko eskatu zitzaien.
  - Gerri-aldaka indizea (GAI): GAI, gerri eta aldaka perimetroen arteko erlazioa da eta bi parametro hauen bidez honela kalkulatzen da:

$$\textbf{GAI} = \frac{\text{Gerriko Perimetroa (cm)}}{\text{Aldakako Perimetroa (cm)}}$$

  - Bernako perimetroa: Neurketa parte-hartzailea aulki batean eserita, besoak erlaxatuta zituela eta pisua bi hanketan berdin banatuta egin zen. Bi bernen neurketa gauzatu zen.

9. Irudia: Bernako perimetroa. **Iturria:** Propioa

3.4.4.3. Dual-Energy X-ray Absorptiometry: DXA

Sarkopenia identifikatzeko parametro muskular zein funtzionalak erabiltzen dira. Hau dela eta, aldagai ebaluagarriak masa, indarra eta errendimendu fisikoa izan ohi dira. Pertsona ororen masa muskular zein gantz kantitatearen kuantifikazioa egitea ez da erraza, dauden metodo guztiek (ordenagailu bidezko tomografia,

erresonantzia magnetiko nuklearra, X-izpi energiako absortziometria duala etab.) beraien abantailak zein desabantailak dituztelako (Cruz-Jentoft eta lank., 2010; Cruz-Jentoft eta lank., 2019).

Gure kasuan nahiz eta kostu altuko metodoa izan (Guglielmi eta lank., 2016), X-izpi energiako absortziometria duala (DXA) erabiltzeko parada izan genuen. Hori bai, soilik 0 eta 12. Asteetan gauzatu ahal izan genituen. Zehazki HOLOGIC QDR 4500 DXA erabiliz zen eta horren bitartez hainbat parametroak aztertu ziren.

Azterturiko parametroak honakoak izan ziren:

- Hezurren eduki minerala.
- Hezurren dentsitate minerala.
- Gorputzeko gantz-masa: gorputzean dagoen gantz kantitatea.
- Gorputzeko gantza horren ehunekoa.
- Masa magroa.
- Masa muskular apendikularra.

3.4.5. Historia Klinikoak

Hirugarren adineko edozein pertsonen aurretiko informazioa izateak berebiziko garrantzia du. Beraz parte-hartzaileak gehiago ezagutu edota interbentzio bat diseinatu zein norbanakoari doitzeko ezinbestekoa da historia klinikoak eskuratzeko aukera izatea. Denok dakigun moduan Osakidetzan paziente bakoitzak historia kliniko bat dauka. Bertan bere osasun bizitzaren pasarteak irakurri daitezke. Baita ere beste hainbat informazio gordetzen da, hala nola, gaixotasun, komorbilitate, ospitalizazio zein larrialdietara eginiko bisitak eta abar luze bat.

Gure eskuhartzea, aurrez esan bezala, ospitalean jorratu zenez Osakidetzaren Osabide Global izeneko programa informatikoaren bitartez parte-hartzaile bakoitzaren historia klinikoetan sartzeko parada izan zen. Honen bitartez parte-hartzaileen hainbat aldagai jaso genituen.

Jarraian horietariko batzuk zerrendaturik daude:

- Pazienteen datu demografikoak: sexua eta adina
- Datu soziodemografikoak: hezkuntza-maila, bakarrik bizi ziren edo ez, oinez ibiltzeko laguntza gailurik duten eta eraikinera sartzeko irisgarritasunarekin (igogailua duten ala ez, atarian eskailerak dituzten ala ez, ataria zero kota den ala ez …) erlazionaturiko informazioa.
- Barthel eta Lawton Index-eko puntuaketak (Mahoney eta Barthel, 1965; Lawton eta Brody, 1969).
- Komorbilitatea: Charlson-en komorbilitate-indizearen bidez ebaluatua. Indize honen bitartez 10 urterako bizi-itxaropena neurtzen da. 20 item kontuan izaten

ditu, zeintzuk subjektuaren bizi-itxaropenean modu zuzenean eragiten dutela egiaztaturik daude.

Lortutako puntuazioa geroz eta handiagoa izan, orduan eta hiltzeko arrisku handiagoa adierazten du (Charlson eta lank., 1987; Charlson eta lank.,, 1994).

- Ospitalizazio egunak: parte-hartzaile bakoitzak ospitalean igaro zituen egun kopurua zenbatu zen.
- Ospitalizazioen zenbatekoa eta zergatiak: interbentzioa hasi aurreko urtean eta interbentzioa hasi zenetik urte betera izandakoak.
- Larrialdietarako bisiten zenbatekoa eta zergatia: interbentzioa hasi aurreko urtean eta interbentzioa hasi zenetik urte betera izandakoak.
- Heriotza: interbentzioa hasi zutenetik urte betera heriotza datak.
- Tratamendu framakologikoen zenbatekoa: parte-hartzaile bakoitzak dituen farmako kantitate eta motak jaso ziren.

3.4.6. Sarkopenia eta Hauskortasuna

3.4.6.1. Sarkopenia

Sarkopenia ebaluatzeko Adineko Pertsonentzako Sarkopeniari buruzko Europako Lan Taldeak (EWGSOP2) proposatutako mozketa-puntuak erabili ziren (Cruz-Jentoft eta lank., 2019). Hala, euste-erresistentzia (eskuko eta besaurreko indarra) txikia (<27 kg gizonezkoentzat eta <16 kg emakumezkoentzat) edo altxa eta eseri testean bost igoera osatzeko 15 segundo baino gehiago behar zituzten parte-hartzaileak sarkopenia jasateko hautagai gisa sailkatu ziren. Horietatik, gizonen kasuan masa muskular apendikularrean 7,0 kg/m^2-tik beherakoa izan zenean, eta emakumeen kasuan, 5,5 kg/m^2-tik beherakoa izan zenean sarkopenia baieztatu zen (Cruz-Jentoft eta lank., 2019).

Testak	**Gizonezkoentzako mozketa puntuak**	**Emakumezkoentzako mozketa puntuak**
WGSOP2 sarkopenia: indar gutxi goi zein behe adarretan		
Euste-erresistentzia	<27 kg	<16 kg
Altxa eta eseri	>15 segundo bost altxadietarako	
EWGSOP2 sarkopenia: masa muskularra txikia (DXA)		
Masa muskular apendikularra/altuera^2	<7.0 kg/m^2	<5.5 kg/m^2

10. Irudia: EWGSOP2-k sarkopenia identifikatzeko sortutako mozketa puntuetatik guk erabilitakoak**. Iturria:** Cruz-Jentoft eta lank., 2019

3.4.6.2. Hauskortasuna

Fried-en hauskortasun eskala bost irizpide hartzen ditu kontuan: nahi gabeko pisu galera, animo egoera kaxkarra, ibilera abiadura motela, jarduera fisiko gutxi burutzea

eta ahultasun muskularra. (Fried eta lank., 2001). Ebaluazioa ere hurrenkera horretan gauzatu behar da. Irizpide bakoitzak 0-1ko eskalan kalifikatzen da, errendimendu osoaren puntuazio-tartea 0-5 puntukoa izanik. Gehienezko puntuazioa beraz bost izango da eta zenbat eta puntuazio altuago izan hauskortasun maila altuagoa adierazten du. Hiru puntutik gora parte-hartzaileak hauskorrak dira. Erabilitako materiala honakoa izan zen: besaurrerik gabeko aulkia, dinamometroa, kronometroa, zinta itsaskorra eta distantziak neurtzeko zinta metrikoa (20 m).

Jarraian eskala nola gauzatu zen zerrendaturik dago:

- Nahi gabeko pisu galera:
  - Puntuazioa: galderari baiezkoa ematen bazion, puntu bat gehitzen zen. Honetan hutsunea bagenu MNA galdetegian, azkenaldian ea nahi gabeko pisu galera izan duen galdera erabiltzen genuen.

- Animo egoera (akidura):
  - Puntuazioa: galderari baiezkoa erantzuna ematen bazion, puntu bat jasotzen zen. Honetan hutsunea bagenu EQ-5D galdetegian, azkenaldian ea urduri edo gogo baxuz egon diren galdera erabiltzen genuen. Bertan 3 edo gehiago erantzunez gero baiezkotzat hartzen zen.

- Ibilera abiadura motela:

Altuera ♂ denbora (abiadura)	Altuera denbora (abiadura)
≤173cm ≥6,1s (0,66m/s) >173cm ≥5,2s (0,77m/s)	≤159cm ≥6,1s (0,66 m/s) >159cm ≥ 5,2s (0,77 m/s)

  - Puntuazioa: behean ikusgai dauden mozketa puntuetan oinarrituz, parte-hartzaileei lau metro ibili ostean bere denbora eta altueraren arabera puntu bat edo zero ematen zitzaien.
    Alegia, mozketa puntuak adierazten duena baino denbora gehiago behar izanez gero puntu bat ematen zitzaien.

- Jarduera fisiko gutxi burutzea:
  - Puntuazioa: galderari baiezkoa erantzuna ematen bazion, puntu bat jasotzen zen. Honetan hutsunea bagenu azelerometro bitartez jasotako astebeteko neurketan 5000 pauso baino gutxiago egin zituztenek puntu bat jasotzen zuten.

Asteko jarduera fisikoa
♀≤ 2h/astean (<270 kcal/astean) ♂ ≤ 2:30h/astean (<383 kcal/astean)

- Ahultasun muskularra:
  - Puntuazioa: behean ikusgai dauden mozketa puntuetan oinarrituz, parte-hartzaileei dinamometro bidez eskuko zein besaurreko indarra neurtu ostean bere kg eta GMI-aren arabera puntu bat edo zero ematen zitzaien.

GMI ♀ Eskuko eta besaurreko indarra	GMI ♂ Eskuko eta besaurreko indarra
< 23 eta ≤ 17kg	< 24 eta ≤ 29kg
23,1-26 eta ≤ 17,3kg	24,1-26 eta ≤ 30 kg
26,1-29 eta ≤ 18kg	26,1-28 eta ≤ 30kg
> 29 eta ≤ 21kg	> 28 eta ≤ 32kg

Alegia, mozketa puntuak adierazten duena baino indar gutxiago izanez gero puntu bat ematen zitzaien.

3.4.6.3. Markatzaile biologikoak

Sarkopenia eta hauskortasunaren inguruan, azken urteotan sortutako interesa dela eta hauskortasunarekin lotura izan dezaketen zenbait biomarkatzaileren inguruan ere interesak gora egin du. Horien artean, ikerketa honetarako muskuluetatik eratorritako miostatina proteina eta honen *in vitro* jarduera inhibitu eta *in vivo*-n muskulu-hazkundea bultza dezakeen folistatina proteina hautatutakoak daude.

Odol laginak ebaluazio epeetan jaso ziren, beraz ikerketa osoa gauzatu zuten parte-hartzaileei hiru lagin atera zitzaizkien. Neurketa hauek ere ohiko analitikak egiteko baliatu ziren. Lagin guztiak ospitalean eta bertako erizainek jaso zituzten eta parte-hartzaileak goizean goiz eta baraurik etorri ziren.

Jaso ondoren, laginen analisiak UPV/EHUko Fisiologia Saileko laborategietan burutu ziren. Jasotako lagin hodiek 10 minutuz 5.000 b/min-ko zentrifugazioa izan zuten. Parte-hartzaile bakoitzetik ateratako gazura -80 °C-an gorde zen aurreragoko analisietarako. Enzyme-linked immunosorbent assay (ELISA) teknika erabili zen bi biomarkatzaileen kontzentrazio serikoak neurtzeko. Miostatina totala eta follistatina (ng/mL) fabrikatzailearen protokoloaren arabera neurtu ziren (GDF-8/Myostatin eta Follistatin Quantikine ELISA Kits R&D Systems Inc., Minneapolis, MN, AEB). Bi kasuetan, kuantifikazioa espektrofotometrikoki egin zen, hots, FLUOstar OPTIMA Microplate reader-en (ThermoFisher Scientific, Waltham, MA, USA) eta Optima Control software 2.20 bertsioaren (BMG, LABTECH, Ortenberg, Alemania) bidez. Analisiak bikoiztuta eta batez besteko bitartez neurtu ziren.

3.4.7. Proba neuropsikologikoak

3.4.7.1. Mini-Mental State Examination (MMSE)

Mini-Mental State Examination edo baita ere Folstein eskala kognitibo moduan ezagutzen dena, nazioartean zabalduen dagoen test kognitiboetako bat da. Narriadura kognitiboa aztertzeko erabiltzeaz gain eta honen eboluzioaren jarraipenerako ere baliagarria da. Hamaika galderaz osatutako eta goi mailako bost funtzio kognitiboak aztertzen dituen galdeketa da. Bost funtzioak honakoak dira: orientazioa, atxikipena, arreta eta kalkulua, oroimena eta hizkuntza.

Puntuazioari dagokionez aipatu 30ekoa dela puntuazio altuena eta 0 baxuena. Pertsona helduetan gorte-puntua 24koa da. Beraz, esan daiteke 24 puntutik gorako emaitzek normaltasun bat adierazten dutela eta 24tik behera narriadura kognitiboa iradokitzen dute. Narriadura hori honela sailkatu daiteke: 23-21 punturekin arina, 20-11 punturekin moderatua eta 10 puntutik behera zorrotza (Folstein eta lank., 1975).

Aurrez adierazi bezala gure ikerketan, gehienez narriadura kognitiboa (20 puntu edo gehiago) zuten pertsonak parte hartu zuten. Eskala kognitibo hau ikerketaren hasieran zein bukaeran pasa zitzaien.

3.4.7.2. Short Portable Mental Status Questionnaire (SPMSQ)

Short Portable Mental Status Questionnaire baita ere Pfeiffer eskala moduan ezagutzen da. Hau, 65 urtetik gorako pertsonen narriadura kognitiboa antzemateko oso azkar pasa eta erraz erabiltzen den test kognitiboa da (Pfeiffer, 1975). Horrez gain ospitale askotan beraien screening-erako erabiltzen dutenez ikerketarako erreklutamenduaren lehen pausuan SPMSQ bertsio Espainiarra erabiltzea erabaki genuen (De la Iglesia Martínez eta lank., 2001).

Test kognitibo hau hamar galderaz osatua dago epe labur eta luzerako oroimena, orientazioa eta matematika-lanak seriean egiteko gaitasuna aztertzen ditu. Akats kopuru osoa jaso behar da, beraz gehienez 10 puntu lor daitezke eta gutxienez 0. Emaitza osoari puntu bat kendu behar zaio parte-hartzaileak lehen hezkuntza egina baldin bazuen, eta puntu bat (akats bat) gehitu parte-hartzaileak bigarren hezkuntza egina baldin bazuen. Narriadura hori akatsen bitartez honela sailkatu daiteke: 0-2 punturekin egoera normala, 3-4 punturekin narriadura arina, 5-7 punturekin narriadura moderatua eta 8-10 punturekin narriadura zorrotza. Beraz zenbat eta puntuazio baxuagoa izan egoera kognitibo hobea.

4.

EMAITZAK

RESULTS

4. EMAITZAK / RESULTS

The results section of this doctoral thesis will be presented in the form of four papers derived from the research project. Three of them have been published, while the remaining is the most recent manuscript and is pending submission.

Futhermore, it is important to demonstrate that the cooperation between the University of the Basque Country and the University of Bordeaux through co-tutelage also resulted in another article (9. appendix) which, although focused on hospitalized elderly people, in this case all participants suffered from cancer. In other words, the doctoral student, in addition to participating in this project, was able to enjoy and work on other research projects during his international stay.

Article 1:

Determinants of participation in a post-hospitalization physical exercise program for older adults

Miriam Urquiza, Iñaki Echeverria, Ariadna Besga, María Amasene, Idoia Labayen, Ana Rodriguez-Larrad, Julia Barroso, Mikel Aldamiz and Jon Irazusta.

BMC Geriatrics (2020), 20:408 doi:10.1186/s12877-020-01821-3

Article 2:

Multicomponent Physical Exercise in Older Adults after Hospitalization: A Randomized Controlled Trial Comparing Short- vs. Long-Term Group-Based Interventions

Iñaki Echeverria, Maria Amasene, Miriam Urquiza, Idoia Labayen, Pilar Anaut, Ana Rodriguez-Larrad, Jon Irazusta and Ariadna Besga.

Int. J. Environ. Res. Public Health (2020), 17(2), 666; doi:10.3390/ijerph17020666

Article 3:

Effects of Short and Long-Term Group-Based Multicomponent Exercise Interventions on Frailty and Sarcopenia: A Randomized Controlled Trial

Article 4:

Identification of frailty and sarcopenia in hospitalised older people

Iñaki Echeverria, Ariadna Besga, Begoña Sanz, María Amasene, Gotzone Hervás, Julia Barroso, Ana Rodriguez-Larrad and Jon Irazusta.

Eur J Clin Invest. (2021), 00:e13420. doi: 10.1111/eci.13420

4.1. Article 1:

Determinants of participation in a post-hospitalization physical exercise program for older adults.

Miriam Urquiza, Iñaki Echeverria, Ariadna Besga, María Amasene, Idoia Labayen, Ana Rodriguez-Larrad, Julia Barroso, Mikel Aldamiz and Jon Irazusta.

Received: 20 April 2020; Accepted: 6 October 2020; Published Online: 16 October 2020

BMC Geriatrics **2020**, 20:408; doi:10.1186/s12877-020-01821-3

Abstract

Background: Older patients often experience a decline in physical function and cognitive status after hospitalization. Although interventions involving physical exercise are effective in improving functional performance, participation in physical exercise interventions among older individuals is low. We aimed to identify factors that contribute to exercise refusal among post-hospitalized older patients.

Methods: A cross-sectional study of recruitment data from a randomized controlled trial was conducted involving 495 hospitalized people ≥70 years old. Sociodemographic and clinical data were obtained from the Basque Public Health System database. We determined physical function with the Short Physical Performance Battery (SPPB), nutritional status with the Mini-Nutritional Assessment, frailty according to the Fried phenotype criteria, and cognitive function with the Short Portable Mental Status Questionnaire (SPMSQ). Student's t, Mann-Whitney U, or chi-squared tests were applied for bivariate analysis. Parameters significantly associated with participation were introduced in a logistic multivariate regression model.

Results: Among the analyzed patients, 88.8% declined participation in the physical exercise program. Multivariate regression revealed that older age (OR: 1.13; 95% CI: 1.07–1.19), poor nutritional status (OR: 0.81; 95% CI: 0.69–0.95), and reduced home accessibility (OR: 0.27; 95% CI: 0.08–0.94) were predictors of participation refusal. Moreover, patients who declined participation had worse performance on the SPPB ($P < 0.05$) and its tests of balance, leg strength, and walking speed ($P < 0.05$). No differences were found between groups in other variables.

Conclusions: This study confirms low participation of older adults in a post-hospitalization physical exercise program. Non-participation was associated with increased age, poor nutritional status, and reduced home accessibility. Our findings support the need for intervention design that accounts for these factors to increase older patient participation in beneficial exercise programs.

Keywords: Physical exercise, Older people, Participation, Post-hospitalization

Background

Older patients tend to experience physical and cognitive decline after hospitalization for an acute illness [1, 2]. Additionally, loss of physical and cognitive capacities may continue months after discharge [3, 4]. Functional decline is directly related to negative outcomes in the year following hospital admission, including dependence, increased risk of institutionalization, and mortality [5]. Total medical expenditures at one year post-discharge grow in proportion to functional impairment, with a potential economic impact due to loss of physical and cognitive function following hospitalization [6].

Physical exercise improves both physical and cognitive performance in older individuals and multicomponent exercise interventions, including resistance, balance, and walking exercises performed during acute hospitalization increase muscle strength, functional capacity, and ability to complete basic daily living activities [7, 8]. Physical exercise also benefits executive function and memory and can reduce the risk of developing dementia [9]. Unfortunately, exercise program participation rates among older adults are usually low [10], including for interventions performed after hospital discharge [11, 12]. Posthospitalization exercise programs for cardiac rehabilitation or knee or hip repair, in which physical exercise is a well-established part of treatment, have higher participation [13], but most discharged older patients will not participate in such a program. To increase participation in physical exercise programs, it is important to determine factors associated with refusal to participate [11]. Studies exploring older patients' reasons for non-participation in physical exercise programs have been performed through surveys or interviews without accounting for clinical or functional variables [14, 15]. Thus, the first aim of the present study was to identify reasons for older adults rejecting participation in a physical exercise program after hospital discharge. The second aims was to analyze physical, clinical, and sociodemographic factors associated with non-participation. Understanding the determining factors of exercise refusal will help inform the development of future strategies aimed at increasing older adult participation in physical exercise programs following hospitalization.

Methods

Study design and participants

This cross-sectional study was a secondary analysis based on data obtained from recruitment for a randomized controlled trial (RCT) comparing two supervised physical exercise interventions of different lengths of the supervised part [16]. The protocol was registered retrospectively under the Australian and New Zealand Clinical Trials Registry with the identifier ACTRN12619000093189 (date of registration: 22/01/2019). The Clinical Research Ethics Committee University Hospital of Araba (2017–021) approved

the study protocol, which complied with the revised ethical guidelines of the Declaration of Helsinki (2013 revision). All participants provided informed written consent before enrollment in the study.

RCT enrollment data were obtained from September 2017 to July 2018 in the Departments of Internal Medicine and Neurology at the Santiago University Hospital of Araba (Basque Country, Spain). Both departments have a high prevalence of older people who usually experience rapid deconditioning due to hospitalization. Eligible participants included men and women ≥70 years who scored ≥20 on the Mini-Mental State Examination (MMSE) [17] and were able to stand and walk independently or with assistance for at least 4 m. The MMSE is a 30-point test used in clinical settings to measure cognitive impairment and to screen for dementia. The cut-off point was set at ≥20 to ensure patients could follow the instructions of the physical exercise program. Exclusion criteria were a diagnosis of chronic kidney disease, autoimmune neuromuscular disease, acute myocardial infarction, or bone fracture in the past three months.

During the recruitment period, 2365 non-surgical patients were admitted to the Departments of Internal Medicine and Neurology of University Hospital of Araba, a tertiary teaching hospital in the Basque Country. After screening medical histories and inclusion criteria, 509 patients were eligible to initiate the physical exercise program at discharge. After signing an informed consent document, a comprehensive geriatric assessment was performed by nurses and physicians of the hospital staff and physiotherapists of the research team. Once assessment of each patient was completed, they were given the option of starting a physical exercise program in the same hospital at discharge. Once per week, we also provided informative sessions and distributed informational leaflets throughout the hospital. Of the evaluated patients, 55 agreed to participate and started the physical exercise program, and 454 refused to participate. Those rejecting participation (n = 14) in the program because they were active enough on their own were excluded from analysis. Finally, 495 patients were analyzed (Fig. 1).

Characteristics of the physical exercise program

The characteristics of the program were described previously [16]. Briefly, subjects who agreed to take part in the intervention were randomly assigned to a short (6 weeks) or long (12 weeks) supervised exercise program. In both groups, participants continued the program at home from either 6 weeks or 12 weeks until 24 weeks after the start of the intervention. The program consisted of 1-h group sessions (2 days/week in the supervised part and 5 days/week at home) and included strength, balance and walking training. All sessions began with warm-up exercises (5 min) and continued with strength

training of upper and lower limbs (35 min) tailored to the individual´s functional capacity. Balance training

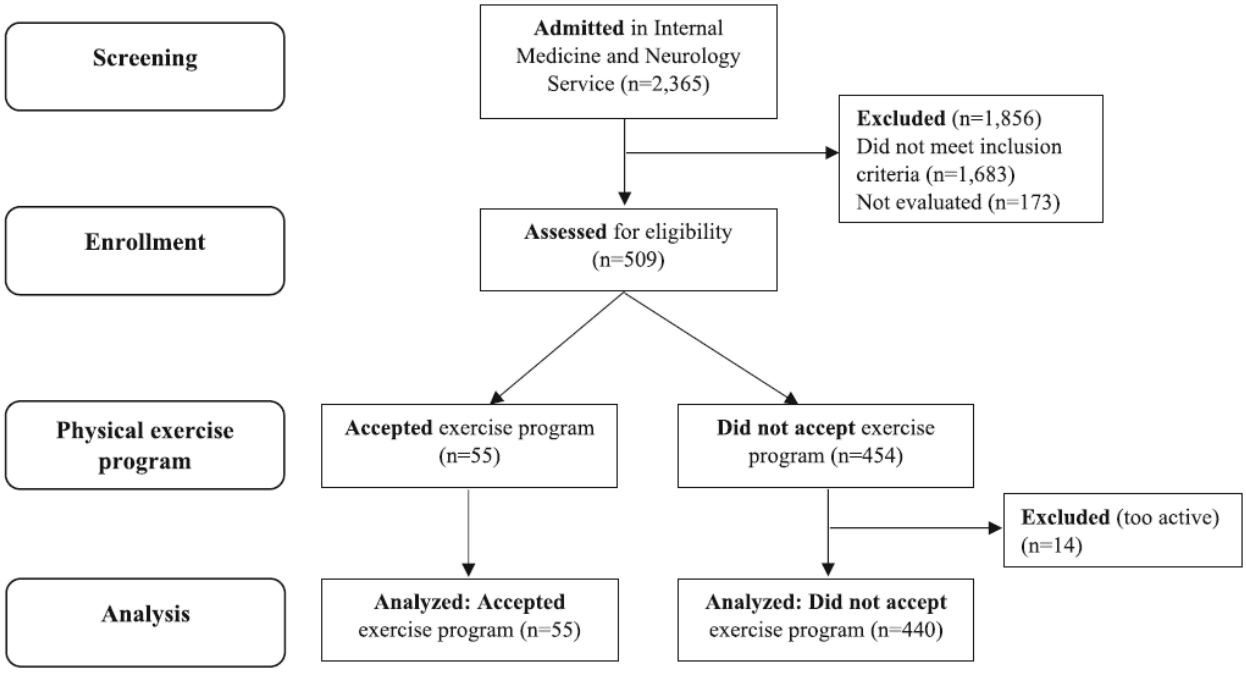


Fig. 1 Study flow diagram

exercises (15min) were also practiced, progressing in difficulty during the program: decreasing arm and base of support and increasing the complexity of movements. Finally, participants were recommended to perform walking sessions on their own. The first participant started the exercise intervention in November 2017 and the last participants ended the program in January 2019.

We asked patients who refused participation in the exercise program to provide reasons for not participating. We categorized refusal reasons as internal reasons, external reasons, and those pertaining to a lack of interest in physical exercise. Internal reasons related to the patients themselves reporting poor health. External reasons related to the patients' social burdens (travel problems, being a family caregiver, or social problems). Uninterested patients simply had no interest in the physical exercise program.

Measurements

Sociodemographic and clinical data were retrieved from the Basque Public Health Service's database. The following data were collected: patient demographic data (sex and age), days of hospitalization, hospitalizations in the previous year, emergency care admissions, and comorbidity (assessed through the Charlson comorbidity index, a method of categorizing patient comorbidities based on the International Classification of Diseases) [18]. We collected the Barthel Index score, which measures performance

in basic activities of daily living such as continence and mobility [19]. In addition, we collected the Lawton Index score which measures the instrumental activities of daily living necessary for independence in the community [20]. Finally, we collected socio-demographic data, including patient educational level, whether or not they live alone, and whether they use assistive devices for walking and home accessibility, such as home entrance-related assistance, e.g. an elevator or lift [21].

Physical function was measured individually in patients' hospital rooms by the Short Physical Performance Battery (SPPB) [22]. SPPB is a battery of tests that combines assessment of balance, gait speed, and lower limb strength. The balance test measured ability to stand for 10 s in side-by-side, semi-tandem, and tandem stands. To assess gait speed, we measured the time to walk 4m at the patients' usual speed twice (participants could use a walking aid if necessary). The best walking time of the two measurements was scored. Finally, lower limb strength was measured by time to perform five repeated chair stands, and the sit-to-stand speed was determined. Each test was scored on a scale of 0–4 points, with a total performance score range of 0–12 points using cutpoint criteria established by Guralnik et al. [22]. Higher scores indicate better physical function.

Nutritional status was measured using the calf circumference short form of the Mini Nutritional Assessment (MNA-SF) [23]. The MNA-SF is a validated screening tool designed by Nestle to identify elderly persons at risk of malnutrition. The test consists of five questions (appetite or eating problems, recent weight loss, mobility impairment, acute illness/stress, dementia, or depression) and measurement of calf circumference (CC). CC was measured at the calf's greatest circumference with the patient sitting down, resting their feet on the floor, and knees bent 90°. The test provides a maximum score of 14 points. Higher scores indicate better nutritional status.

Frailty was measured according to the Fried phenotype criteria [24]. A Spanish language version of the frailty performance criteria was used to measure grip strength, walking speed, weight loss, physical activity, and exhaustion.

Cognitive function was measured by the Spanish validated version of the Short Portable Mental Status Questionnaire (SPMSQ) [25]. The SPMSQ includes ten questions to briefly test short- and long-term memory, orientation, and capacity to perform serial mathematical tasks. The total number of errors was counted and one point was subtracted if the patient had a grade school education and one point was added if the patient had a high school education.

Statistical analyses

Continuous variables were expressed as means with standard deviations (SD), and categorical variables were expressed as frequency counts and percentages (%).

Normality of data was assessed using the Kolmogorov- Smirnov test. Sociodemographic characteristics and clinical data of patients who initiated or declined participation in the post-hospitalization physical activity program were compared. Differences in continuous variables were analyzed by the Students' t test (normal distribution data) or the Mann-Whitney U test (non-normal distribution data), and a chi-squared test was used to compare categorical variables. Variables with $P < 0.05$ in univariate analysis were considered eligible for a backward multivariate logistic regression model to predict participation in the program. The goodness fit of the model was evaluated using the Hosmer-Lemershow test. The Omnibus test was used to determine whether the explained variance was significantly higher than the unexplained variance. Finally, Nagelkerke's R2 estimated the proportion of the dependent variable explained by independent variables introduced in the model. Statistical significance was set at $P < 0.05$. IBM SPSS 21 software (IBM, Chicago, IL) was used to perform statistical analysis.

Results

This study included 495 hospitalized older adults. The mean age of evaluated patients was 83.6 ± 6.6 years, 257 (51.9%) were men, and the mean Charlson comorbidity index was 6 ± 1.9 points. Of the reasons for hospital admission, 43.6% were infection-related, 27.5% were acute decompensated heart failure, and 13.1% were chronic airflow limitation. The remaining 15.8% of admissions were due to other conditions (falls, delirium, dementia, and others). Almost 9 out of 10 evaluated patients declined participation in a post-hospitalization physical exercise program and 50.7% of patients refused participation due to a lack of interest in the physical exercise program (Table 1).

Table 1 Refusal reasons

Internal reasons	
Poor health perception	9.5%
External reasons	39.8%
Travel problems	24.9%
Other assistance resource	10.2%
Family caregiver	2.6%
Social problems	2.1%
Not interested in physical exercise program	50.7%

Patients who declined participation were significantly older than those who initiated the program ($P = 0.011$). Additionally, a significantly higher percentage of patients who needed walking assistance devices ($P = 0.004$) and had poor accessibility at home ($P = 0.019$) did not participate in the program. There were no significant differences between groups regarding sex, education level, living alone, length of hospitalization, or previous year hospital admissions (Table 2).

Table 2 Sociodemographic characteristics

	Initiated PE program (n = 55)	Declined participation (n = 440)	P
Age (years), mean (SD)	81.7 (5.9)	83.9 (6.7)	0.011[#]
Sex			0.874
Men, % (n)	52.7% (29)	52% (229)	
Women, % (n)	47.3% (26)	48% (211)	
Education level			0.563
≤ 12 years, % (n)	30.4% (7)	36.4% (122)	
> 12 years, % (n)	69.6% (16)	63.6% (213)	
Length of stay (days), mean (SD)	6.8 (3.5)	7.6 (4.3)	0.112
Previous year hospital admission			0.718
Yes, % (n)	36.4% (20)	33.9% (149)	
No, % (n)	63.6% (35)	66.1% (219)	
Previous year emergency care, mean (SD)	1.7 (2.2)	1.5 (2.5)	0.171
Walking assistance device			0.004[$]
Yes, % (n)	49.1% (27)	69% (240)	
No, % (n)	50.9% (28)	31% (108)	
Lives alone			0.346
Yes, % (n)	36.4% (20)	30.1% (114)	
No, % (n)	63.6% (35)	69.9% (265)	
Home accessibility			0.019[$]
Yes, % (n)	94.5% (52)	81.6% (224)	
No, % (n)	5.5% (3)	18.4% (50)	

PE physical exercise, SD standard deviation ; [#] Mann-Whitney U test; [$] chi square test

Patients who declined participation had significantly worse functional performance on the SPPB (P = 0.015), including poorer muscle strength in the lower limbs (P = 0.024), lower balance scores (P = 0.011), and slower walking speed (P = 0.004), than participants who agreed to the exercise program (Table 3).

Table 3 Clinical, functional, cognitive, and nutritional parameters

	Initiated PE program (n = 55)	Declined participation (n = 440)	P
Weight, mean kg (SD)	71.7 (15.2)	67.3 (13.1)	0.021*
Barthel index, mean (SD)	87 (17.3)	86.2 (17.5)	0.551
Lawton scale, mean (SD)	4.9 (2.7)	4.1 (2.7)	0.065
SPMSQ, mean (SD)	1.4 (1.5)	2 (2.1)	0.089
SPPB, mean (SD)	6.6 (3.1)	5.6 (3)	0.015[#]
Sit-to-stand speed, stand/s	0.25 (0.16)	0.2 (0.16)	0.024[#]
Balance test	69.6% (16)	63.6% (213)	0.011[#]
Walking test, s	6.8 (3.5)	7.6 (4.3)	0.004[#]
MNA-SF, mean (SD)	11.3 (2.2)	10.1 (2.5)	< 0.001[#]
Eating problems	1.7 (0.5)	1.4 (0.8)	0.014[#]
Weight loss	2.2 (1.1)	1.9 (1.2)	0.015[#]
Mobility	1.9 (0.3)	1.8 (0.4)	0.256
Acute illness/stress	0.8 (0.4)	0.8 (0.4)	0.537
Dementia/depression	2 (0.1)	1.9 (0.3)	0.106
Calf circumference	2.6 (1)	2.3 (1.3)	0.067
Frailty (Fried criteria), mean (SD)	2.8 (1.3)	2.9 (1.2)	0.710
Charlson comorbidity index, mean (SD)	5.9 (2.1)	6 (1.9)	0.434

PE physical exercise, SD standard deviation, SPMSQ Short Portable Mental Status Questionnaire, MNA-SF Mini Nutritional Assessment Short Form, SPPB Short Physical Performance Battery
* Student's t test; [#] Mann-Whitney U test

Further, uninterested patients had lower nutritional status according to the MNA-SF test (P < 0.001). Analysis of each component of the test showed that patients who refused to participate in the program had significantly lower scores for both weight (P = 0.015) and eating problems (P = 0.014). There were no significant differences between groups in Barthel and Lawton scales, cognitive status, comorbidities measured by the Charlson index, or frailty according to the Fried phenotype.

Backward multivariate logistic regression analysis was performed on the variables in the model (age, walking assistance device use, home accessibility, weight, SPPB, and MNA-SF) and revealed that higher age (OR: 1.13; 95% CI: 1.07–1.19), lower MNA-SF test score (OR: 0.81; 95% CI: 0.69–0.95), and lack of home accessibility (OR: 0.27; 95% CI: 0.08–0.94) were independent predictors of participation refusal (Fig. 2).

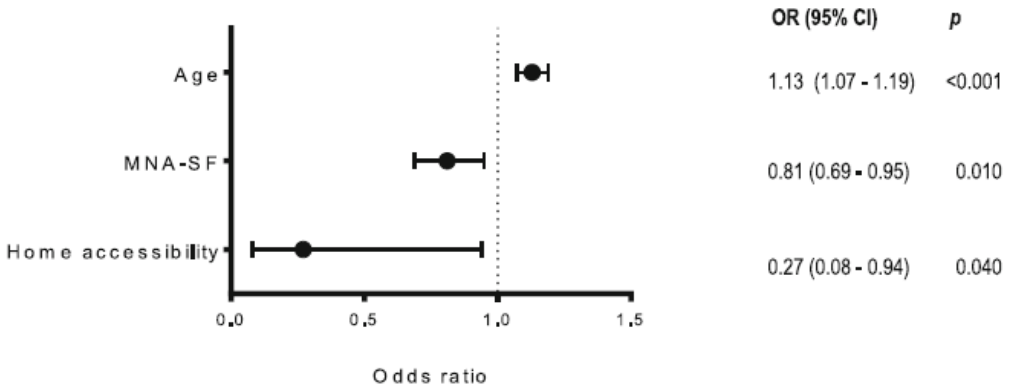


Fig. 2 Backward multivariate logistic regression model according to participation in a post-hospitalization physical exercise program. Variables in the first equation included age, walking assistance device, home accessibility, weight, SPPB scores, and Mini Nutritional Assessment Short Form (MNA-SF) metrics. Estimates were based on: n = 313 due to missing values; Hosmer-Lemershow goodness of fit, P = 0.614; Omnibus P < 0.001; and R2 Nagelkerke = 0.191

Discussion

Difficulty in engaging older people in physical exercise programs is highly prevalent; however, there is limited information about the clinical characteristics that serve as barriers preventing participation in physical posthospitalization interventions [11]. The present study reveals that older adults have low interest in participating in post-hospitalization physical exercise programs, and that non-participation associates with physical, nutritional, and social parameters. Likewise, increased age, poor nutritional status, and home accessibility problems were strong independent predictors of non-participation.

Barriers to participation in the exercise program

Most post-hospitalization physical exercise programs are carried out in patients undergoing cardiac or lung rehabilitation or after hip or knee repair. Participation rates reported in these programs (30–70%) are higher than in our program [13, 26]. These differences may be due to physical exercise being considered an essential part of rehabilitation after the above-mentioned treatments. Physical exercise after hospitalization is strongly recommended by the European Society of Cardiology [27], the American Thoracic Society, and the European Respiratory Society, and it is usually well accepted by patients, but geriatric patients with broader reasons for hospitalization similar to those in our study (mainly infections) often do not consider exercise a useful intervention after discharge. Higher participation rates were reported in previous post-hospitalization physical exercise programs for older adults; however, the participants in those interventions were slightly younger than in the present study [11, 12]. Nevertheless, the participation rate in our study was similar to other physical exercise programs for community-dwelling older adults, with rates of 7.3–13% in studies with similar participant characteristics [10].

It is remarkable that the main reason for nonparticipation for half of the patients was a lack of interest in physical exercise. This lack of interest was described in other older adult populations who do not recognize the positive health benefits of physical activity [29, 30]. Other barriers, such as social influences, e.g., lack of encouragement from others, physical limitations (pain or discomfort), or low self-efficacy are present in older populations [31, 32].

In this sense, health professionals may play a fundamental role in informing patients about physical and cognitive deterioration associated with hospitalization [1, 2] and the benefits of physical exercise after discharge to revert these deleterious effects [7]. For these reasons, it is pertinent to actively encourage patients to get involved in physical exercise programs as part of a structured posthospitalization treatment and take into account patient perceptions and engagement factors when designing exercise interventions for this population.

We also found that poor accessibility at home was an independent factor for non-participation in the physical exercise program. This result agrees with other qualitative studies in which accessibility or environmental barriers hinder access to exercise programs [33]. Usually, poor accessibility is associated with lower socioeconomic status, one of the most important predictors of negative health outcomes [34]. Additionally, transport difficulties were reported as barriers for a quarter of those who declined to participate in the exercise program. This result agrees with other studies that define poor access to transport as a relevant barrier to older people's physical activity participation [33]. Therefore, special efforts are needed to improve incorporation of

people with lower economic status in physical exercise programs and provide economical and accessible transport to facilities where physical exercise is performed.

Participant characteristics

People who refused to participate were older than those who accepted the exercise program. Logistic regression models showed that the probability of non-participation increased by 13% with each additional year of age. This finding agrees with post-hospitalization cardiac rehabilitation programs where participation declines significantly after 70 years of age, and non-participation rates are even lower at 80 years of age [35]. Similar results were found in lung rehabilitation post-hospitalization programs [36].

We did not find sex-related differences in participation. However, a previous study found significantly lower participation of women after a cardiac event [13]. These differences should be assessed with caution because there may be age, social, or disease-related differences among participants. For instance, older women in the Basque population are as physically active as older men [37], which could account for the lack of sex-related differences in our study.

Additionally, patients who participated in the program had better nutritional status. Interestingly, nutritional status was included in the last equation of the logistic regression model as an independent predictor of participation, which indicates strength of the relationship between nutrition and participation in physical exercise. Malnutrition and poor functional performance are closely interrelated—malnutrition is associated with a higher risk of sarcopenia [38] and, consequently, poorer functional status. Malnutrition in older people is due to multiple factors [39], led by medical illnesses, mental health conditions, psychological causes, or social isolation [40]. Additionally, malnutrition or risk of malnutrition in older people is directly associated with multiple negative outcomes, including increased mortality [41], longer hospital stays, and poorer quality of life [42, 43]. Interventions to improve nutritional and physical status regularly include exercise. Our findings suggest that it is necessary to reduce barriers to developing exercise interventions and to improve older patients' participation in post-hospitalization exercise programs, especially for patients who generally refuse to participate. Further, lower participation among patients with worse nutritional status is worrying because these individuals are prone to functional deterioration [42].

A strength of this study is its objective clinical measurement of reasons for non-participation in a posthospitalization physical exercise program and its evaluation of nutritional and functional variables. To our knowledge, few studies have analyzed participation in post-hospitalization physical exercise programs for patient's receiving care in internal medicine and neurology departments. Further, other studies analyze

only qualitative and socioeconomic parameters for older adults' non-participation [44, 45]. The main limitations of this study relate to it being a secondary analysis of an RCT.

On one hand, certain people who would participate in a conventional physical exercise program might not be willing to participate in a research trial. On the other hand, some variables that could be relevant for nonparticipation have not been assessed, such as selfefficacy, social support, or socio-economic status, which could influence non-participation. In addition, this study is limited by its cross-sectional nature, which excludes any ability to determine temporality and causality. Finally, the fact that there were only 55 participants could reduce the statistical power of the results.

Conclusions

Participation of older patients in a post-hospitalization physical exercise program was low, especially among patients with poor nutritional status and low accessibility at home. These findings inform strategies to improve accessibility and increase older adult participation in physical exercise programs following hospitalization. To prevent health inequality, non-participants should have the opportunity to receive social support, e.g. assistance with transportation, and nutritional intervention to increase their willingness to participate. Efforts are needed to increase participation in physical exercise programs, specifically in populations that are less prone to participate.

References

1. Graf C. Functional decline in hospitalized older adults: It's often a consequence of hospitalization, but it doesn't have to be. AJN Am J Nurs. 2006;106(1):58–61.
2. Mathews SB, Arnold SE, Epperson CN. Hospitalization and cognitive decline: can the nature of the relationship be deciphered? Am J Geriatr Psychiatry. 2014;22(5):465–80.
3. Chen CCH, Wang C, Huang GH. Functional trajectory 6 months posthospitalization: a cohort study of older hospitalized patients in Taiwan. Nurs Res. 2008;57(2):93–100.
4. Wilson RS, Hebert LE, Scherr PA, Dong X, Leurgens SE, Evans DA. Cognitive decline after hospitalization in a community population of older persons. Neurology. 2012;78(13):950–6.
5. Campbell SE, Seymour DG, Primrose WR, Almazan C, Arino S, Dunstan E, et al. A systematic literature review of factors affecting outcome in older medical patients admitted to hospital. Age Ageing. 2004;33(2):110–5.
6. Greysen SR, Stijacic Cenzer I, Boscardin WJ, Covinsky KE. Functional impairment: an unmeasured marker of Medicare costs for Postacute Care of Older Adults. J Am Geriatr Soc. 2017;65(9):1996–2002.
7. Martínez-Velilla N, Casas-Herrero A, Zambom-Ferraresi F, Sáez de Asteasu ML, Lucia A, Galbete A, et al. Effect of exercise intervention on functional decline in very elderly patients during acute hospitalization. JAMA Intern Med. 2019;179(1):28–36.
8. Valenzuela PL, Morales JS, Castillo-García A, Mayordomo-Cava J, García-Hermoso A, Izquierdo M, et al. Effects of exercise interventions on the functional status of acutely hospitalised older adults: a systematic review and meta-analysis. Ageing Res Rev. 2020;101076.
9. Bherer L, Erickson KI, Liu-Ambrose T. A review of the effects of physical activity and exercise on cognitive and brain functions in older adults. J Aging Res. 2013;2013.

10. Van Der Deijl M, Etman A, Kamphuis CBM, Van Lenthe FJ. Participation levels of physical activity programs for community-dwelling older adults: a systematic review. BMC Public Health. 2014;14(1):1301.
11. Deer RR, Goodlett SM, Fisher SR, Baillargeon J, Dickinson JM, Raji M, et al. A randomized controlled pilot trial of interventions to improve functional recovery after hospitalization in older adults: feasibility and adherence. J Gerontol. 2018;73(2):187–93.
12. Brovold T, Skelton DA, Bergland A. Older adults recently discharged from the hospital: effect of aerobic interval exercise on health-related quality of life, physical fitness, and physical activity. J Am Geriatr Soc. 2013;61(9):1580–5.
13. Ruano-Ravina A, Pena-Gil C, Abu-Assi E, Raposeiras S, Van' t Hof A, Meindersma E, et al. Participation and adherence to cardiac rehabilitation programs. A systematic review. Int J Cardiol. 2016;223:436–43.
14. Burton E, Farrier K, Lewin G, Pettigrew S, Hill AM, Airey P, et al. Motivators and barriers for older people participating in resistance training: a systematic review. J Aging Phys Act. 2017;25(2):311–24.
15. Cavill NA, Foster CEM. Enablers and barriers to older people's participation in strength and balance activities: A review of reviews. J Frailty Sarcopenia Falls. 2018;3(2):105.
16. Echeverria I, Amasene M, Urquiza M, Labayen I, Anaut P, Rodriguez-Larrad A, et al. Multicomponent physical exercise in older adults after hospitalization: A randomized controlled trial comparing short-vs. long-term group-based interventions. Int J Environ Res Public Health. 2020;17(2):666.
17. Folstein MF, Folstein SE, McHugh PR. "Mini-mental state". A practical method for grading the cognitive state of patients for the clinician. J Psychiatr Res. 1975;12(3):189–98.
18. Charlson ME, Charlson RE, Peterson JC, Marinopoulos SS, Briggs WM, Hollenberg JP. The Charlson comorbidity index is adapted to predict costs of chronic disease in primary care patients. J Clin Epidemiol. 2008;61(12):1234–40.
19. Mahoney FI, Barthel DW. Functional evaluation: the Barthel index: a simple index of independence useful in scoring improvement in the rehabilitation of the chronically ill. Md State Med J. 1965;14:61–5.
20. Lawton MP, Brody EM. Assessment of older people: self-maintaining and instrumental activities of daily living. Gerontologist. 1969;9:179–86.
21. Portegijs E, Rantakokko M, Viljanen A, Rantanen T, Iwarsson S. Perceived and objective entrance-related environmental barriers and daily out-ofhome mobility in community-dwelling older people. Arch Gerontol Geriatr. 2017;69:69–76.
22. Guralnik JM, Simonsick EM, Ferrucci L, Glynn RJ, Berkman LF, Blazer DG, et al. A short physical performance battery assessing lower extremity function: association with self-reported disability and prediction of mortality and nursing home admission. J Gerontol. 1994;49(2):M85–94.
23. Kaiser MJ, Bauer JM, Ramsch C, Uter W, Guigoz Y, Cederholm T, et al. Validation of the mini nutritional assessment short-form (MNA®-SF): a practical tool for identification of nutritional status. J Nutr Heal Aging. 2009; 13(9):782.
24. Fried LP, Tangen CM, Walston J, Newman AB, Hirsch C, Gottdiener J, et al. Frailty in older adults: evidence for a phenotype. J Gerontol A Biol Sci Med Sci. 2001;56(3):M146–57.
25. Pfeiffer E. A short portable mental status questionnaire for the assessment of organic brain deficit in elderly patients. J Am Geriatr Soc. 1975;23(10): 433–41.
26. Benzo R, Wetzstein M, Neuenfeldt P, McEvoy C. Implementation of physical activity programs after COPD hospitalizations: lessons from a randomized study. Chron Respir Dis. 2015;12(1):5–10.
27. Piepoli MF, Corrà U, Benzer W, Bjarnason-Wehrens B, Dendale P, Gaita D, et al. Secondary prevention through cardiac rehabilitation: from knowledge to implementation. A position

paper from the cardiac rehabilitation section of the European association of cardiovascular prevention and rehabilitation. Eur J Cardiovasc Prev Rehabil. 2010;17(1):1–17.
28. Spruit MA, Singh SJ, Garvey C, Zu Wallack R, Nici L, Rochester C, et al. An official American thoracic society/European respiratory society statement: key concepts and advances in pulmonary rehabilitation. Am J Respir Crit Care Med. 2013;188(8):e13–64.
29. Chen YM. Perceived barriers to physical activity among older adults residing in long-term care institutions. J Clin Nurs. 2010;19(3–4):432–9.
30. Guerin M, Mackintosh S, Fryer C. Exercise class participation among residents in low-level residential aged care could be enhanced: a qualitative study. Aust J Physiother. 2008;54(2):111–7.
31. Hill AM, Hoffmann T, McPhail S, Beer C, Hill KD, Brauer SG, et al. Factors associated with older patients' engagement in exercise after hospital discharge. Arch Phys Med Rehabil. 2011;92(9):1395–403.
32. Ferguson K, Bradley JM, McAuley DF, Blackwood B, O'Neill B. Patients' perceptions of an exercise program delivered following discharge from hospital after critical illness (the revive trial). J Intensive Care Med. 2019; 34(11–12):978–84.
33. Franco MR, Tong A, Howard K, Sherrington C, Ferreira PH, Pinto RZ, et al. Older people's perspectives on participation in physical activity: a systematic review and thematic synthesis of qualitative literature. Br J Sports Med. 2015;49(19):1268–76.
34. Kollia N, Caballero FF, Sánchez-Niubó A, Tyrovolas S, Ayuso-Mateos JL, Haro JM, et al. Social determinants, health status and 10-year mortality among 10,906 older adults from the English longitudinal study of aging: the ATHLOS project. BMC Public Health. 2018;18(1):1357.
35. Sun EY, Jadotte YT, Halperin W. Disparities in cardiac rehabilitation participation in the United States. J Cardiopulm Rehabil Prev. 2017;37(1):2–10.
36. Puhan MA, Gimeno-Santos E, Cates CJ, Troosters T. Pulmonary rehabilitation following exacerbations of chronic obstructive pulmonary disease. Cochrane Database Syst Rev. 2016;12.
37. Kortajarena M, Zarrazquin I, Irazusta J, Gil-Goikouria J, Irazusta A, Hervás G, et al. Objectively and subjectively measured physical activity and its relation to cardiovascular risk factors in older people—which is most appropriate? Maturitas. 2019;123:61–6.
38. Hu X, Zhang L, Wang H, Hao Q, Dong B, Yang M. Malnutrition-sarcopenia syndrome predicts mortality in hospitalized older patients. Sci Rep. 2017; 7(1):3171.
39. Willis H. Causes, assessment and treatment of malnutrition in older people. Nurs Older People. 2017;29(2);20–5.
40. Boulos C, Salameh P, Barberger-Gateau P. Social isolation and risk for malnutrition among older people. Geriatr Gerontol Int. 2017;17(2):286–94.
41. Söderström L, Rosenblad A, Thors Adolfsson E, Bergkvist L. Malnutrition is associated with increased mortality in older adults regardless of the cause of death. Br J Nutr. 2017;117(4):532–40.
42. Agarwal E, Miller M, Yaxley A, Isenring E. Malnutrition in the elderly: a narrative review. Maturitas. 2013;76(4):296–302.
43. Sharma Y, Thompson C, Shahi R, Hakendorf P, Miller M. Malnutrition in acutely unwell hospitalized elderly - "The skeletons are still rattling in the hospital closet". J Nutr Heal Aging. 2017;21(10):1210–5.
44. Flink M, Brandberg C, Ekstedt M. Why patients decline participation in an intervention to reduce re-hospitalization through patient activation: whom are we missing? Trials. 2019;20(1):82.
45. Ecarnot F, Meunier-Beillard N, Quenot J-P, Meneveau N. Factors associated with refusal or acceptance of older patients (≥ 65 years) to provide consent to participate in clinical research in cardiology: a qualitative study. Aging Clin Exp Res. 2019:1–8.

4.2. Article 2:

Multicomponent Physical Exercise in Older Adults after Hospitalization: A Randomized Controlled Trial Comparing Short- vs. Long-Term Group-Based Interventions.

Iñaki Echeverria, Maria Amasene, Miriam Urquiza, Idoia Labayen, Pilar Anaut, Ana Rodriguez-Larrad, Jon Irazusta and Ariadna Besga.

Received: 12 November 2019; Accepted: 17 January 2020; Published: 20 January 2020

Int. J. Environ. Res. Public Health **2020**, 17, 666; doi:10.3390/ijerph17020666

Abstract: Multicomponent physical exercise is effective in curbing the effect of hospitalization in older adults. However, it is not well established which characteristics of the exercise interventions would optimize intervention sustainability and efficacy. This study compared the effects of two group-based multicomponent exercise interventions of different lengths in older adults after hospitalization. Fifty-five participants were randomly assigned to a short-term group-based branch (SGB, n = 27) or to a long-term group-based branch (LGB, n = 28). The SGB participated in a six-week multicomponent group-based exercise-training program followed by 18 weeks of home-based exercise. The LGB completed 12 weeks of each phase. Physical function, physical activity, quality of life, anthropometrics, and nutritional status were assessed at baseline, after 12 weeks, and after 24 weeks of intervention. Both groups improved physical function and nutritional status and increased physical activity after 12 weeks of intervention (paired student's t-test, $p < 0.01$), and maintained the positive effects during the following 12 weeks. No group-by-time interaction was observed in any of the studied variables using mixed-model ANOVA. Based on these findings, we determined that 6 weeks of a group-based exercise intervention caused similar functional and nutritional benefits to a longer group-based intervention of 12 weeks when both are continued at home until 24 weeks.

Keywords: post-hospitalization; older adults; multicomponent exercise program; physical function; nutrition; quality of life

1. Introduction

By 2050, the percentage of the world's population that is over age 60 will reach an estimated 22% due to an increase in life expectancy [1]. The process of aging encompasses changes in body composition, with reductions in muscle and bone mass and increases in fat mass, leading to functional performance decline [2]. This progressive loss of functional performance is one of the most important health-related problems linked to aging. Low physical function is related to a high incidence of malnutrition, falls, high morbidity, mortality, and disability, along with reductions in quality of life [3,4]. Thus, the loss of physical function represents a challenge for older adults and carries an associated increase in health-related resource demand and economic burden [5].

The addition of stress to the aging process, due to illness or a hospitalization, usually accelerates deconditioning. Hospitalization in older patients is associated with decreased muscle strength and muscle mass loss and worsens nutritional status and quality of life [6]. The strong association between stress and deterioration can increase the risk of negative outcomes such as dependence or mortality [7–9], and this particularly affects the oldest patients [10]. This decline in capacities may continue months after discharge [10,11], even more than one year following hospital admission [12], and without appropriate intervention, hospital-associated deconditioning has the potential to chronically precipitate poor outcomes [13,14].

Multicomponent physical exercise programs including strength, endurance, and balance training are effective in attenuating the adverse effects associated with aging [15–17]. When performed during or after acute hospitalization, these interventions increase muscle strength and functional capacity and are effective in improving physical function and cognitive status [18–21]. However, exercise interventions are often difficult to implement during hospitalization due to disease severity and the complexity of medical care. Most post-hospitalization physical exercise programs are utilized with patients undergoing cardiac and lung pathologies or after hip or knee repair [22–24]. However, few studies assess post-hospitalization exercise programs in older adults with conditions for which exercise is not considered part of the treatment [19,25]. In addition, the social and economic cost of physical exercise interventions is a cause of concern. Therefore, effective and sustainable interventions to accelerate the recovery of physical function after hospital discharge are warranted [26].

Most physical exercise interventions could be categorized as group-based or home-based. In a clinical setting, group-based exercise is monitored by qualified staff who ensure attention to exercise technique and proper exercise performance, allowing for increases in and optimization of the loads and difficulty of the exercises and facilitate follow-up [27,28]. However, experienced trainers and transport to facilities are

necessary, making these programs more difficult to maintain long-term. In contrast, home-based exercise programs have some benefits over group-based exercise approaches, including the tailoring of exercise to lifestyle preferences, participant autonomy, flexibility in timing, low cost to the individual, and no need for travel. Nevertheless, there are some limitations to home-based programs, including the need for strong self-discipline to adhere to the program and lack of a social element of the program (the latter is considered a positive element of group exercise) [29]. Typically, the higher the intensity of supervision, the greater the improvements [30,31], but there is no consensus on what programs provide the greatest improvements in older adults. In some programs, after initial supervised sessions to facilitate performance and adherence, there is a period of home-based sessions. These programs can take advantage of both types of interventions. In fact, more positive effects in the long-term were found when there was follow-up at home or in a community after finishing a group-based intervention [14,32,33]. In this case, the length of the group-based component could be a limiting factor due to its economic and social cost. Hence, high-quality randomized controlled trials have been proposed to evaluate graded approaches, implementing different stages of exercise supervision [34].

Therefore, we aimed to compare the benefits of two multicomponent physical exercise interventions with different group- and home-based period lengths on physical function, physical activity, quality of life, anthropometry, and nutritional status among older adults after hospitalization.

2. Materials and Methods

2.1. Study Design

This was a 24-week single-blinded randomized controlled intervention study. Participants were randomly assigned to either a short-term group-based branch (SGB) or a long-term group-based branch (LGB). The SGB consisted of six weeks of group sessions in the hospital and 18 weeks of individual sessions at home. The LGB undertook a 12-week group exercise session in the hospital with an additional 12 weeks completed at home. The study was approved by the Committee on Ethics in Research at the University Hospital of Araba (CEIC-HUA Code Expte. 2017-021). Written informed consent was obtained from all study participants before enrollment in the study. The protocol was registered under the Australian and New Zealand Clinical Trials Registry (ANZCTR) with the identifier ACTRN12619000093189.

Participants were recruited from the Internal Medicine and Neurology services of the University Hospital of Araba (HUA). Eligible participants were aged ≥70 years, scored ≥20 on the Mini Mental State Examination (MMSE) [35], and were able to walk (with or without assistive devices) independently for at least 4 m. All participants provided

informed consent. Exclusion criteria were a diagnosis of chronic kidney disease, severe dementia, autoimmune neuromuscular disease, acute myocardial infarction or a bone fracture in the last three months, or refusal to sign the informed consent form.

In total, 2365 patients were admitted during the recruitment period. Once screened, 509 patients were eligible to initiate the physical exercise program at discharge. After signing the informed consent document, participants were evaluated in their hospital room and prepped to start a physical exercise program at the same hospital at discharge. Among these evaluated patients, 55 accepted participation in the physical exercise program at discharge. Participants were randomly assigned (in a 1:1 ratio) using sealed opaque envelopes to either the SGB or LGB by coin-toss sequence generation. All volunteers received detailed study information through the research team; objectives, measurement variables, and other details about the interventions were explained orally and in writing to both potential participants and their families. Finally, 27 patients were assigned to the SGB and 28 to the LGB. A flow diagram describing the recruitment of participants is shown in Figure 1.

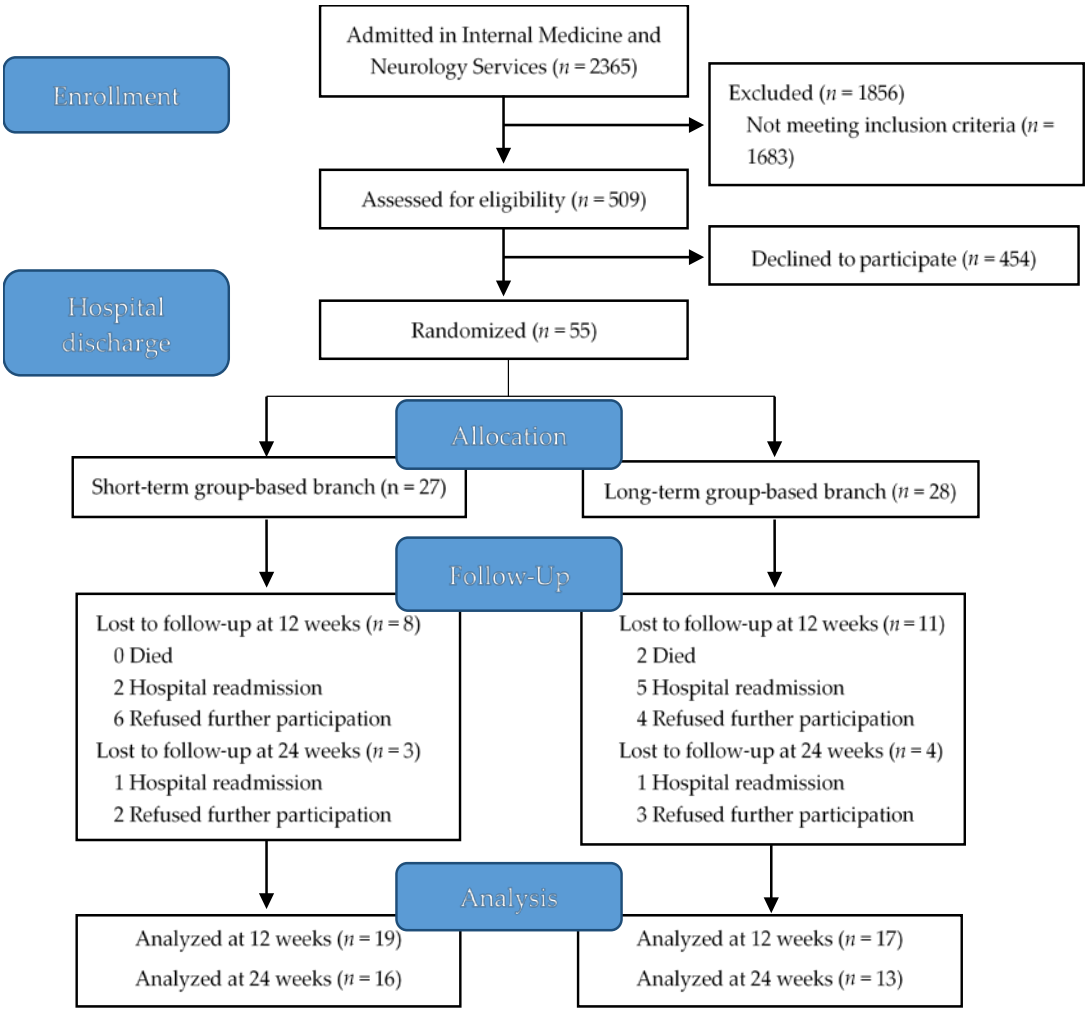


Figure 1. Flow diagram of participant selection.

2.2. Group-Based and Home-Based Interventions

The group-based intervention consisted of multicomponent physical exercise sessions designed to improve strength, power, balance, and walking conducted by experienced physical trainers. The program's technical content was based on the authors' previous experience in a population with a high prevalence of frail older adults [36]. The intervention was adapted to meet the exercise and physical activity guidelines for older adults established by the American College of Sports Medicine (ACSM) and the American Heart Association (AHA) [37,38]. The program was individualized based on each participant's physical function, and progression was set up accordingly.

The group-based program was performed in a room equipped ad hoc at the hospital and consisted of 60-min group sessions conducted twice a week with exercises intended to improve strength, power, and balance. An interval of at least 48 h between training sessions was respected. All sessions began with a brief warm-up of 5 min (range-of-motion exercises for the neck, wrists, shoulders, hip, knees, and ankles). Strength training (35 min) comprised upper- and lower-limb exercises (arm curl, leg flexion, hip extension, leg abduction, standing on tip-toes and heels, and chair stand) performed with external weights and tailored to each participant´s physical function via the Brzycki equation [39] for the estimation of one-repetition maximum (1-RM). In the first three weeks, exercise was performed with light loads (40%–50% 1-RM) to ensure an appropriate introduction and familiarization with resistance training exercises, and thereafter, loads were increased to 60%–70% of each participant´s 1-RM, to obtain additional benefits if they were well tolerated.

Balance training (for 15 min) included exercises of progressing difficulty, starting with decreasing hand support (with two hands at first, then with one hand, and finally, none, if possible) along with decreasing the base of support (both feet together, semi-tandem, and tandem position, while increasing the complexity of movements). The progression of each balance exercise was adapted and individualized weekly and exercises varied. Typical exercises were weight transfer from one leg to another, walking with small obstacles, proprioceptive exercises, and stepping practice. Sessions finished with five minutes of cooling down by stretching, breathing, and relaxing. Training attendance was recorded for every session. A session was considered complete when 80% or more of the programmed exercises were performed.

The home-based intervention was influenced by the Otago Exercise Program and the European Vivifrail project [40,41]. The schedule for each week and patient consisted of five days of multicomponent exercises and seven days of walking recommendations. Exercises were learned during the group-based period. Walking retraining was also implemented through individualized recommendations, with the goal of performing outdoor walking sessions without assistance. Walking recommendations started with

15 min per day at the beginning of the intervention with the goal of completing 45–60 min/day by the end of the program. Walking intensities were based on each participant's 6-min walk test performance. Every two weeks, the staff supported the participants, addressed any concerns, and registered adherence via phone call. In this case, there were five sessions carried out per week rather than two in the group-based period. Compliance with the multicomponent exercise was considered successful when each subject performed 50% or more of the session.

2.3. Measurements

Measurements were recorded in both groups before the intervention began (week 0), at the end of the long group-based phase (week 12), and after the full intervention period (week 24; Figure 2). All measurements were evaluated at the same location, and all outcomes were collected by the same trained researchers.

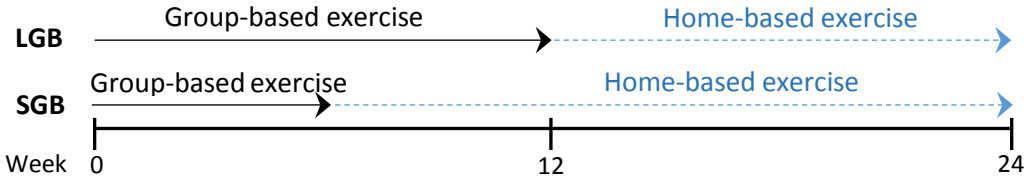


Figure 2. Exercise program duration and measurements weeks.

2.3.1. Socio-Demographic and Clinical Data

The following data were retrieved from the Basque Public Health Service's database: patient demographic data (sex and age), comorbidity [assessed through the Charlson Comorbidity Index (CCI)], and basic and instrumental activities of daily living (Barthel and Lawton Indexes). Socio-demographic data including patients educational level, whether or not they live alone, use of assistive devices for walking, and home accessibility (defined as not having home entrance-related environmental barriers, i.e., not having elevator/lift or ramp) were also collected.

2.3.2. Physical Function, Physical Activity, and Quality of Life

The primary outcome was functional capacity, measured by the Short Physical Performance Battery (SPPB) [42]. Physical function assessment included a handgrip strength test (Jamar dynamometer) [43], balance per the Berg scale [44], normal and fast 8-m walking speed [45], and four tests from the Senior Fitness Test: the 30-s chair-stand test (CST), the arm-curl test (ACT), 8-ft timed up-and-go test (8-ft TUGT), and the 6-min walk test (6mWT) [46]. These tests were used to assess functional capacity, lower- and upper-limb strength, gait speed, static and dynamic balance, and aerobic endurance.

Time spent at different intensities of physical activity and the number of steps per day during free living of everyday life were recorded with an accelerometer (Actigraph

GT3X model; Actigraph LLC, Pensacola, FL, USA) that participants wore on the hip with a belt for a seven-day period. Active-period intensities were classified as light, moderate, or vigorous following the criteria developed by Freedson et al., and the number of minutes performed at each intensity was measured [47]. Participants did not receive specific instructions to walk during the assessments.

Quality of life (QoL) was assessed using the Spanish version of the EuroQol–5 Dimension (EQ-5D-5L) questionnaire. EQ-5D-5L combines the assessment of the visual analog scale of the self-rated health score (EQ VAS Score) and the health index (EQ-5D-5L Index Value) [48].

2.3.3. Anthropometry and Nutritional Status

Anthropometry measurements were obtained before functional assessments. An experienced nutritionist who was internationally certified in anthropometric testing (ISAK level 1) obtained all anthropometric measurements following the protocol recommended by the International Society for the Advancement of Kinanthropometry [49].

Height was measured with a Seca213 stadiometer to the nearest 0.1 cm, and body mass was measured with an OmronHN288 digital scale to the nearest 0.1 kg. Calf, arm, waist, and hip circumference was measured with non-elastic anthropometric tape (CESCORF) to the nearest 0.1 cm. Body mass index (BMI) was calculated based on height and mass, and the waist-to-hip ratio was based on waist and hip circumferences.

Nutritional status was evaluated qualitatively using the Mini Nutritional Assessment test (MNA) [50], which was completed by the participant and/or the participant's relative or caregiver. This questionnaire contains 18 items divided into four categories: anthropometric assessment, general assessment, short dietary assessment, and subjective assessment. Each answer has a numerical value contributing to the final score. A maximum of 30 points can be obtained. Scores ranging from 24 to 30 reflect normal nutritional status, scores from 17 to 23.5 reflect a risk of malnutrition, and a score under 17 reflects malnutrition [50].

2.4. Sample Size and Statistical Analyses

Sample size was calculated to detect minimal significant effects on SPPB accepting an alpha risk of 0.05 and a beta risk of 0.20 in a bilateral contrast. A total of 63 individuals were required to detect a difference equal to or greater than 1 unit in the SPPB (SD = 2.00). The sample size was increased, with an additional 20% (loss during follow-up) and 5% (mortality). The resultant sample size required was 84 individuals or 42 individuals per group. Qualitative data are presented as percentages. Chi-squared test was used to compare two groups at baseline. Quantitative data are presented as mean ± SD. Normal distribution of the data was determined by the Shapiro–Wilk test. When not normally

distributed, the data were square-root transformed. Comparisons of quantitative data between two groups at baseline were performed using an unpaired t-test and chi-squared. Group-by-time differences were assessed using mixed design analysis of variance (ANOVA; two time points × two groups) with two different levels (weeks 0–12 and weeks 12–24). Eta squared (η2) was calculated to estimate the effect size. Values for η2 of ≤0.02, ≤0.13, ≥013, and ≥0.26 were considered small, medium, medium-large and large, respectively [51]. Comparisons of the changes within each group were performed with paired Student's t-tests. Thresholds of 0.1, 0.3, 0.5, 0.7, and 0.9 were used for small, moderate, large, very large, and extremely large effects, respectively, as suggested by Cohen [52]. Relationships between categorical variables (contingency tables) were determined by a chi-square test (χ2). The significance level for all tests was $p < 0.05$. Statistical analysis was performed using the IBM SPSS Statistics 24 statistical software package (SPSS, Inc., Chicago, IL, USA).

3. Results

3.1. Study Participants

From September 2017 to July 2018, a total of 509 (21.5%) patients admitted to the Internal Medicine and Neurology services of the HUA were screened for eligibility. Among the evaluated patients, 55 started the program (Figure 1). According to hospital admission records, 41.8% admissions were infection-related, 18.2% were due to stroke without motor impairment, 16.4% were decompensated heart failure admissions, and 5.5% were due to falls. The remaining 18% of the admissions were due to other conditions (neurological, delirium, anemia, etc.). Of the 55 patients (26 females, 47.3%) that were initially enrolled, 19 (SGB = 8 and LGB = 11) were lost to follow-up before the 12-week time point. The total number of subjects lost to follow-up at the 24-week time point was 26 (SGB = 11 and LGB = 15, Figure 1). The descriptive characteristics of the study participants are explained in Table 1. No significant differences between the two groups existed at baseline. The program was ceased before reaching the estimated sample size because the difficulties in the recruitment. In addition, at that moment, the primary outcome measure was far from the expected difference between the two assessed interventions.

Table 1. Descriptive characteristics of study participants.

	SGB	**LGB**
Age (years), mean ± SD	82.9 ± 5.7 (*n* = 27)	82.26 ± 5.5 (*n* = 28)
Body height (cm), mean ± SD	158.8 ± 8.4 (*n* = 27)	158.2 ± 8.5 (*n* = 28)
MMSE (0–30), mean ± SD	25.2 ± 2.3 (*n* = 27)	25.1 ± 3.3 (*n* = 28)
Barthel index, mean ± SD	86.8 ± 17.9 (*n* = 27)	84.8 ± 18.7 (*n* = 28)
Lawton and Brody index, mean ± SD	5 ± 2.5 (*n* = 27)	4.5 ± 2.3 (*n* = 28)
CCI, mean ± SD	5.6 ± 2 (*n* = 27)	5.9 ± 2 (*n* = 28)
Education level ≤ 12 years (%)	60 (*n* = 25)	60.9 (*n* = 23)

Used walking assistance device (%)	60.9 (*n* = 23)	57.7 (*n* = 26)
Entrance environmental barriers (%)	24 (*n* = 25)	19.2 (*n* = 26)
Live alone (%)	32 (*n* = 25)	37 (*n* = 27)

SGB = short-term group-based branch; LGB = long-term group-based branch; MMSE = Mini Mental State Examination; CCI = Charlson comorbidity index.

3.2. Adherence and Compliance

Mean attendance rates for the group-based exercise sessions were 1.81 days/week (90.4% of the sessions) in the SGB and 1.74 days/week (87% of the sessions) in the LGB. Compliance with the walking recommendation was 6.92 days/week (97.6% of the days) in the SGB and 5.63 days/week (80.4% of the days) in the LGB. During the home-based period, the SGB performed the exercises 4.1 days/week (82.3% of the sessions) and the LGB performed the exercises 3.4 days/week (67.9% of the sessions) on average. There was no significant difference between groups, except in walking recommendation compliance ($p = 0.008$). No adverse events associated with the prescribed exercises were recorded, and no patients had to interrupt the intervention because of adverse events.

3.3. Physical Function, Physical Activity, and Quality of Life Outcomes

Significant improvements were obtained in almost all parameters in both groups from baseline through week 12 (Table 2). A clinically and statistically significant increase was observed in the main outcome of this trial, the SPPB score (SGB $p < 0.001$; Cohen's d = extremely large, and LGB $p < 0.001$; Cohen's d = extremely large). Similarly, the strength of the lower and upper limbs (except for the grip strength of both hands), fast and normal gait speed, static and dynamic balance, and aerobic endurance also increased in both branches after 12 weeks of the intervention. These improvements were maintained from week 12 to week 24 (Table 3). We did not find any significant group-by-time interaction effect in either period (0–12 weeks and 12–24 weeks, Tables 2 and 3). LGB participants in the 0–12 period increased light physical activity ($p = 0.004$; Cohen's d = very large) and the number of steps per day ($p = 0.015$; Cohen's d = large). In contrast, SGB participants increased moderate to vigorous physical activity (MVPA) ($p = 0.026$; Cohen's d = large) during this period. We did not find any significant group-by-time interaction effect in either period (0–12 weeks and 12–24 weeks, Tables 2 and 3). The LGB showed significant improvement in self-rated health ($p = 0.027$; Cohen's d = large) and in the health index ($p = 0.029$; Cohen's d = large) after the first 12 weeks of intervention. There was no significant difference within the SGB. From weeks 12 to 24, when both groups performed home-based physical exercise, there were no significant differences in QoL variables, although there was a trend toward QoL reduction ($p = 0.201$; Cohen's d = moderate) among the LGB.

Table 2. Analysis of physical function and quality of life outcomes (mean ± S.D.) at 0 (pre) and 12 (post) weeks.

	SGB			LGB			η^2
	Pre	**Post**	**Cohen's d**	**Pre**	**Post**	**Cohen's d**	
Physical function							
SPPB score	8.1 ± 3.4	10 ± 2.9 ***	1.269	8.4 ± 2.3	10.7 ± 1.8 ***	1.337	0.002
Hand grip non-dominant (kg)	20.8 ± 6.5	20.2 ± 7.2	0.285	21.5 ± 9.4	21.6 ± 7.8	0.035	0.050
Hand grip dominant (kg)	22.8 ± 6.8	22.5 ± 7.3	0.117	24.7 ± 9.7	25.1 ± 8.8	0.162	0.024
CST (*n* of stands)	9.3 ± 5.7	12.2 ± 6.3 **	1.446	10.4 ± 3.7	13.2 ± 4.3 ***	1.117	0.001
ACT (*n* of repetitions)	15 ± 5.9	20 ± 6.4 ***	1.756	13.4 ± 1.8	20.7 ± 1.6 ***	4.581	0.090
6mWT (m)	324 ± 135	372 ± 118 **	0.917	321 ± 117	383 ± 110 ***	1.282	0.018
8-ft TUGT (m/s)	0.27 ± 0.14	0.32 ± 0.13 **	0.870	0.29 ± 0.08	0.33 ± 0.08 **	0.807	0.003
Gait speed 8 m (m/s)	0.89 ± 0.33	1 ± 0.27 **	0.670	0.91 ± 0.19	1.03 ± 0.18 **	0.799	0.002
Fast gait speed 8 m (m/s)	1.2 ± 0.42	1.4 ± 0.38 **	0.956	1.2 ± 0.32	1.4 ± 0.3 *	0.906	0.019
Berg scale (Pts)	45.7 ± 10.3	50.5 ± 6.4 **	0.943	49.2 ± 3.3	52.5 ± 2.5 ***	1.591	0.047
Physical activity							
LPA (min/day)	160 ± 108	178 ± 116	0.284	132 ± 76.4	162 ± 81.6 **	0.895	0.013
MVPA (min/day)	3.7 ± 5.4	6.6 ± 9.4 *	0.501	4.9 ± 6.9	5.7 ± 7.6	0.159	0.016
Steps (nº of steps/day)	3342 ± 2849	3859 ± 3439	0.240	2722 ± 2136	3630 ± 2347 *	0.631	0.012
Quality of life							
EQ VAS Score	68.3 ± 15.4	77.1 ± 12.1	0.421	60.9 ± 19	72.9 ± 17.3 *	0.589	0.007
EQ-5D-5L Index Values	0.8 ± 0.22	0.88 ± 0.10	0.377	0.69 ± 0.4	0.9 ± 0.14 *	0.572	0.059

SGB = short-term group-based branch; LGB = long-term group-based branch; SPPB Score = Short Physical Performance Battery score; CST = 30-s chair-stand test; ACT = arm-curl test; 6mWT= 6-min walk test; 8-ft TUGT = 8-ft timed up-and-go test; LPA = light physical activity; MVPA = moderate-to-vigorous physical activity; EQ VAS Score = EuroQol Visual Analogue Scale score. *** $p < 0.001$, significantly different from baseline. ** $p < 0.01$, significantly different from baseline. * $p < 0.05$, significantly different from baseline.

Table 3. Analysis of physical function and quality of life outcomes (mean ± S.D.) at 12 (pre) and 24 (post) weeks.

	SGB			LGB			η^2
	Pre	**Post**	**Cohen's d**	**Pre**	**Post**	**Cohen's d**	
Physical function							
SPPB score	10.4 ± 2.7	10.3 ± 2.9	0.099	11.6 ± 1.7	11 ± 1.9	0.809	0.001
Hand grip non-dominant (kg)	20.9 ± 7	22 ± 7	0.457	22.8 ± 8.1	23.6 ± 10.2	0.274	0.003
Hand grip dominant (kg)	23.3 ± 7	23.8 ± 7	0.313	26.3 ± 9.2	26.2 ± 10.1	0.042	0.033
CST (*n* of stands)	13 ± 6	13.13 ± 5.7	0.113	14.4 ± 4.1	14.8 ± 3.9	0.177	0.003
ACT (*n* of repetitions)	19.6 ± 6.8	21.5 ± 7.8	0.798	22.7 ± 6.5	24.9 ± 7	0.393	0.001
6mWT (m)	379 ± 125	388 ± 124	0.323	400 ± 100	405 ± 101	0.191	0.012
8-ft TUGT (m/s)	0.33 ± 0.13	0.33 ± 0.13	0.000	0.35 ± 0.08	0.34 ± 0.08	0.442	0.003
Gait speed 8 m (m/s)	1.03 ± 0.29	1.05 ± 0.27	0.163	1.06 ± 0.19	1.02 ± 0.17	0.425	0.082
Fast gait speed 8 m (m/s)	1.42 ± 0.4	1.38 ± 0.38	0.276	1.41 ± 0.31	1.48 ± 0.36	0.446	0.120
Berg scale (Pts)	51 ± 6.1	51.4 ± 7.3	0.204	52.9 ± 2	53.2 ± 2.7	0.138	0.000
Physical activity							
LPA (min/day)	201 ± 118	219 ± 127	0.307	177 ± 85.9	168 ± 101	0.196	0.064
MVPA (min/day)	8.1 ± 10.1	7.4 ± 7.4	0.123	6.5 ± 8.4	8.1 ± 11.7	0.311	0.057
Steps (nº of steps/day)	4541 ± 3563	4823 ± 4200	0.147	4183 ± 2365	4052 ± 2648	0.167	0.029
Quality of life							
EQ VAS Score	77.2 ± 12.9	75.9 ± 12.7	0.083	77.7 ± 16.5	70.8 ± 17.3	0.375	0.029
EQ-5D-5L Index Values	0.89 ± 0.1	0.89 ± 0.16	0.000	0.92 ± 0.12	0.9 ± 0.11	0.201	0.004

SGB = short-term group-based branch; LGB = long-term group-based branch; SPPB Score = Short Physical Performance Battery score; CST = 30-s chair-stand test; ACT = arm-curl test; 6mWT = 6-min walk test; 8-ft TUGT = 8-ft timed up-and-go test; LPA = light physical activity; MVPA = moderate-to-vigorous physical activity; EQ VAS Score = EuroQol Visual Analogue Scale score.

3.4. Anthropometry and Nutritional Status Outcomes

After the first 12 weeks, both branches improved almost three points on average in the MNA test (SGB 2.92; $p < 0.001$; Cohen's d = extremely large and LGB 2.85; $p = 0.001$; Cohen's d = extremely large). The SGB increased the right ($p = 0.043$; Cohen's d = large) and the left calf ($p = 0.039$; Cohen's d = moderate) perimeter from baseline to week 12. The MNA ranges significantly changed over time in the SGB ($p = 0.004$; $\chi2 = 11.1$) and LGB ($p = 0.004$; $\chi2 = 0.022$). At the beginning of the intervention, most participants were in the at-risk and malnutrition ranges. However, by the end of the long group-based period, most participants had a normal nutritional state. Thus, 52.6% of participants in the SGB and 41.2% of participants in the LGB improved their nutritional status from being at risk of malnutrition to having a normal nutritional status. In the LGB, there was a 17.6% reduction in participants with malnourished status, leaving no participants in this range at the end of the intervention. However, we did not find any significant group-by-time interaction. There was no difference from baseline to 12 weeks in either group in the rest of the anthropometric measurements (Table 4).

Table 4. Analysis of nutritional status and anthropometry outcomes at 0 (pre) and 12 (post) weeks.

	SGB			LGB			η^2
	Pre	**Post**	**Cohen's d**	**Pre**	**Post**	**Cohen's d**	
Nutritional status							
MNA score	22.1 ± 2.6	25 ± 3.6 ***	1.129	21.1 ± 3.7	23.9 ± 2.5 **	0.945	0.000
MNA ranges							
Normal nutritional status *N* (%)	4 (21.1)	14 (73.7) [a]		3 (17.6)	10 (58.8) [b]		
Risk of malnutrition *N* (%)	14 (73.7)	4 (21.1)		11 (64.7)	7 (41.2)		
Malnutrition *N* (%)	1 (5.3)	1 (5.3)		3 (17.6)	0 (0.0)		
Anthropometry							
Body mass (kg)	71.2 ± 15.4	72.3 ± 15.8	0.379	71.8 ± 19.6	71.7 ± 19.9	0.046	0.017
BMI	29.1 ± 7	29.4 ± 7.3	0.235	28.8 ± 7.2	28.8 ± 7.3	0.000	0.024
Calf circumference left	35.9 ± 3.2	36.3 ± 3 *	0.456	35.3 ± 5.3	35.6 ± 5.5	0.314	0.040
Calf circumference right	36.2 ± 3	36.7 ± 3.1 *	0.526	35.5 ± 6	35.6 ± 5.6	0.088	0.012
Arm circumference	27.7 ± 5	27.5 ± 5.3	0.127	26.4 ± 5.1	26.5 ± 4.7	0.101	0.029
Waist circumference	99.5 ± 11	97.8 ± 12.9	0.374	97.3 ± 17.6	98.2 ± 17.7	0.238	0.011
Hip circumference	103 ± 13.2	103 ± 13.8	0.000	101 ± 13.6	99.4 ± 12.1	0.380	0.070
WHR	0.97 ± 0.07	0.96 ± 0.08	0.167	0.96 ± 0.11	0.98 ± 0.1	0.340	0.018

SGB = short-term group-based branch; LGB = long-term group-based branch; MNA = Mini Nutritional Assessment score; BMI = body mass index; WHR = waist-to-hip ratio. Values are means and standard deviations. *** $p < 0.001$, significantly different from baseline. ** $p < 0.01$, significantly different from baseline. * $p < 0.05$, significantly different from baseline. a $p < 0.01$; $\chi2 = 11.1$. b $p < 0.05$; $\chi2 = 7.66$.

From weeks 12 to 24, when both groups performed home-based exercise, we did not find any significant difference in the MNA score and point range or anthropometrical parameters within either group or between the two groups. Nevertheless, it was noticeable that both branches maintained the improvements in nutritional status obtained during the first 12 weeks of the intervention (Table 5).

Table 5. Analysis of nutritional status and anthropometry outcomes at 12 (pre) and 24 (post) weeks.

	SGB			LGB			η2
	Pre	Post	Cohen's d	Pre	Post	Cohen's d	
Nutritional status							
MNA score	26 ± 2.7	25.7 ± 1.9	0.171	24.2 ± 2.7	24.1 ± 3.8	0.037	0.001
Normal nutritional status N (%)	14 (87.5)	15 (93.8)		9 (62.2)	9 (62.2)		
Risk of malnutrition N (%)	2 (12.5)	1 (6.3)		4 (30.8)	3 (23.1)		
Malnutrition N (%)	0 (0.0)	0(0.0)		0 (0.0)	1 (7.7)		
Anthropometry							
Body mass (kg)	71.6 ± 12.3	71.3 ± 12	0.220	69.4 ± 16.4	68.8 ± 16.8	0.281	0.016
BMI	29.1 ± 5.5	29.1 ± 5.5	0.000	28 ± 5.4	27.8 ± 5.6	0.238	0.019
Calf circumference left	36.2 ± 2.8	36.1 ± 2.9	0.096	34.8 ± 4.1	35.2 ± 4.7	0.376	0.003
Calf circumference right	36.4 ± 2.5	36.3 ± 2.5	0.116	34.8 ± 4.2	34.9 ± 4.3	0.123	0.022
Arm circumference	27.1 ± 3.8	27.1 ± 3.8	0.000	25.7 ± 3.4	26.2 ± 3.7	0.514	0.009
Waist circumference	97.3 ± 11.8	97.4 ± 9	0.024	97.3 ± 15.5	98.2 ± 16	0.221	0.092
Hip circumference	102 ± 11.6	102 ± 11.3	0.000	98 ± 9.5	99.6 ± 9.8	0.502	0.008
WHR	0.95 ± 0.09	0.96 ± 0.09	0.198	0.99 ± 0.11	0.98 ± 0.1	0.272	0.067

SGB = short-term group-based branch; LGB = long-term group-based branch; MNA = Mini Nutritional Assessment score; BMI = body mass index; WHR = waist-to-hip ratio. Values are means and standard deviations.

4. Discussion

In the present study, both multicomponent physical exercise interventions implemented at hospital discharge provided significant benefits in physical function and nutritional status, combating the functional decline associated with hospitalization in older adults. The results also suggest that a six-week group-based multicomponent exercise intervention is sufficient to reverse the functional and nutritional decline associated with hospitalization.

Considering that we did not have a control group, it could be that physical improvements observed after hospitalization were simply due to overcoming the acute condition. However, previous studies have demonstrated that in the absence of physical intervention, SPPB score does not improve significantly in the months after hospitalization [18,30,53]. SPPB is a valid instrument for screening the risk of disability [42] and provides important prognostic information to identify older adults at high risk of poor outcomes after hospital discharge [54]. In this study, the SPPB score increased approximately two points during the first 12 weeks of both interventions (only one point is clinically relevant [55]) and these improvements were maintained during the next 12 weeks of home-based intervention. The improvement observed in physical function after both interventions indicates that the assessed programs are effective in reducing the risk of poor outcomes after hospital discharge.

Studies assessing exercise programs to improve recovery after hospital discharge have reported conflicting results regarding their benefits in physical function. The type of intervention (group versus home-based) and the pathologies of the patients could

explain this contradiction. Our results agree with previous works showing that group-based multicomponent programs are efficient in ameliorating or reversing the functional decline associated with hospitalization [18]. In contrast, home-based interventions show more modest results [28,29,53]. The level of supervision seems to be relevant in home-based programs to obtain greater improvements in physical function [27–29]. Some authors propose that the smaller effects of home-based programs on strength could be due to the difficulty of delivering programs at a sufficient intensity in a home setting [53]. Nevertheless, it has been suggested that the recovery of patients' physical function and activity of daily living could be further benefited by a prolonged in-home intervention after exercise programs during hospitalization [32,33]. We observed that home-based physical exercise maintained the physical function and activity achieved in both group-based periods. Our results also agree with previous reports showing that home visits and follow-up telephone calls are effective in maintaining adherence and compliance in home-based exercise [28,33].

Notably, the MNA score improved after the first 12 weeks of intervention. At baseline, both groups were at average risk of malnourishment. After 12 weeks, the mean score in the SGB (25 points) achieved good nutritional status and the LGB was close to having good nutritional status (23.9 points). Accordingly, while most of the participants were at risk of malnutrition at the beginning of the intervention, after 12 weeks, those with good nutritional status outnumbered those at risk of malnutrition and only one subject was malnourished according to the MNA. Notably, this nutritional improvement was maintained in the following three months, with the proportion of participants at an optimal state of nutrition reaching 82.8%. To our knowledge, this is the first study to describe the effects of post-hospitalization interventions on MNA. However, studies performed in other populations demonstrate the effectiveness of physical exercise in improving nutritional status [56]. Our results show that nutritional status was within an acceptable range at the end of the intervention in both groups, suggesting that physical exercise might be a useful tool to improve nutritional status in older adults after hospitalization. The improvements in MNA are especially relevant, taking into account that good scores in both nutritional status and physical function are considered protective factors [57,58] related to a number of adverse outcomes that could induce restricted activity [12] and social isolation of the participants [59]. These can negatively affect the autonomy and QoL of older adults and often go undetected by medical staff.

When we compared the effectiveness of both interventions, the long-term group-based branch was not any more effective than the short-term group-based branch in physical function and nutritional status. Only six weeks of group-based exercise followed by 18 weeks of home-based exercise proved to be sufficient for improving

upper- and lower-limb strength, gait speed, static and dynamic balance, functional capacity, aerobic endurance, physical activity, and nutritional status. This is the first study to evaluate intervention length in this manner.

There are slight differences between the groups in their effects on QoL. Intriguingly, the LGB had a significant increase in QoL at 12 weeks, just when the group-based period finished. It should be noted that SGB had finished its group-based program six weeks before. In contrast, during the home-based period of the LGB, QoL tended to decrease. These results suggest that group-based interventions could be superior to home-based exercises in improving QoL, as proposed in patients with cancer [60] and in elderly people with sarcopenia [28]. The presence of a social element in group-based interventions could explain this difference. However, the absence of group-by-time interaction in our results makes us cautious with any interpretation; more data are needed to clarify this observation.

One of the strengths of the study is that, to the best of our knowledge, this is the first to compare two different lengths of post-hospitalization group-based multicomponent exercise interventions. These findings are relevant to design specific interventions in a hospital setting. In addition, the compliance with the interventions was good, both in the hospital and at home, which supports the feasibility of this type of program. One of the main limitations of this study is the large number (90%) of screened participants who did not accept participation in the study. This may mean that the sample is not fully representative of older people recently discharged from the hospital. The fact that many people with moderate to severe cognitive impairment or unstable cardiac conditions were excluded from the trial also limits the generalizability of the study findings. Our study may be underpowered for some variables due to the small sample size because we were unable to recruit the sample size necessary to detect significant changes in the primary outcome. However, since the effect size of time x group interaction was practically null and the significance was very close to one, it is unlikely that increasing the sample size by 28 people would cause the between-group differences to reach significance.

5. Conclusions

Older adults who participated in both multicomponent exercise interventions evaluated in this randomized controlled trial improved their physical function and nutritional status after hospitalization. Furthermore, we determined that six weeks of a group-based exercise intervention caused similar functional and nutritional benefits to a longer group-based intervention of twelve weeks, when both are continued at home until twenty-four weeks. These results provide valuable information for the design of

practical, feasible, and cost-effective physical exercise interventions following hospitalization in older adults.

References

1. WHO. *Global Age-Friendly Cities: A Guide*; World Health Organization: Geneva, Switzerland, 2007.
2. Brady, A.O.; Straight, C.R.; Evans, E.M. Body Composition, Muscle Capacity, and Physical Function in Older Adults: An Integrated Conceptual Model. *J. Aging Phys. Act*. **2014**, *22*, 441–452, doi:10.1123/japa.2013-0009.
3. Goodpaster, B.H.; Park, S.W.; Harris, T.B.; Kritchevsky, S.B.; Nevitt, M.; Schwartz, A.V.; Simonsick, E.M.; Tylavsky, F.A.; Visser, M.; Newman, A.B. The Loss of Skeletal Muscle Strength, Mass, and Quality in Older Adults: The Health, Aging and Body Composition Study. *J. Gerontol. A Biol. Sci. Med. Sci*. **2006**, *61*, 1059–1064, doi:10.1093/gerona/61.10.1059.
4. Hu, X.; Zhang, L.; Wang, H.; Hao, Q.; Dong, B.; Yang, M. Malnutrition-Sarcopenia Syndrome Predicts Mortality in Hospitalized Older Patients. *Sci. Rep*. **2017**, *7*, 3171, doi:10.1038/s41598-017-03388-3.
5. Tieland, M.; Trouwborst, I.; Clark, B.C. Skeletal Muscle Performance and Ageing. *J. Cachexia Sarcopenia Muscle* **2018**, *9*, 3–19, doi:10.1002/jcsm.12238.
6. Van Ancum, J.M.; Scheerman, K.; Jonkman, N.H.; Smeenk, H.E.; Kruizinga, R.C.; Meskers, C.G.M.; Maier, A.B. Change in Muscle Strength and Muscle Mass in Older Hospitalized Patients: A Systematic Review and Meta-Analysis. *Exp. Gerontol*. **2017**, *92*, 34–41, doi:10.1016/j.exger.2017.03.006.
7. Oliveira, M.R.; Fogaca, K.C.; Leandro-Merhi, V.A. Nutritional Status and Functional Capacity of Hospitalized Elderly. *Nutr. J*. **2009**, *8*, 54, doi:10.1186/1475-2891-8-54.
8. Deutz, N.E.P.; Ashurst, I.; Ballesteros, M.D.; Bear, D.E.; Cruz-Jentoft, A.J.; Genton, L.; Landi, F.; Laviano, A.; Norman, K.; Prado, C.M. The Underappreciated Role of Low Muscle Mass in the Management of Malnutrition. *J. Am. Med. Dir. Assoc*. **2019**, *20*, 22–27, doi:10.1016/j.jamda.2018.11.021.
9. Sauer, A.C.; Goates, S.; Malone, A.; Mogensen, K.M.; Gewirtz, G.; Sulz, I.; Moick, S.; Laviano, A.; Hiesmayr, M. Prevalence of Malnutrition Risk and the Impact of Nutrition Risk on Hospital Outcomes: Results from nutritionDay in the U.S. *JPEN J. Parenter. Enteral Nutr*. **2019**, doi:10.1002/jpen.1499.
10. Chen, C.C.; Wang, C.; Huang, G.H. Functional Trajectory 6 Months Posthospitalization: A Cohort Study of Older Hospitalized Patients in Taiwan. *Nurs. Res.* **2008**, *57*, 93–100, doi:10.1097/01.NNR.0000313485.18670.e2.
11. Wilson, R.S.; Hebert, L.E.; Scherr, P.A.; Dong, X.; Leurgens, S.E.; Evans, D.A. Cognitive Decline After Hospitalization in a Community Population of Older Persons. *Neurology* **2012**, *78*, 950–956, doi:10.1212/WNL.0b013e31824d5894.
12. Gill, T.M.; Allore, H.G.; Gahbauer, E.A.; Murphy, T.E. Change in Disability After Hospitalization or Restricted Activity in Older Persons. *JAMA* **2010**, *304*, 1919–1928, doi:10.1001/jama.2010.1568.
13. Suetta, C.; Magnusson, S.P.; Beyer, N.; Kjaer, M. Effect of Strength Training on Muscle Function in Elderly Hospitalized Patients. Scand. *J. Med. Sci. Sports* **2007**, *17*, 464–472, doi:10.1111/j.1600-0838.2007.00712.x.
14. Kanach, F.A.; Pastva, A.M.; Hall, K.S.; Pavon, J.M.; Morey, M.C. Effects of Structured Exercise Interventions for Older Adults Hospitalized with Acute Medical Illness: A Systematic Review. *J. Aging Phys. Act*. **2018**, *26*, 284–303, doi:10.1123/japa.2016-0372.
15. Cadore, E.L.; Rodriguez-Manas, L.; Sinclair, A.; Izquierdo, M. Effects of Different Exercise Interventions on Risk of Falls, Gait Ability, and Balance in Physically Frail Older Adults: A Systematic Review. *Rejuvenation Res*. **2013**, *16*, 105–114, doi:10.1089/rej.2012.1397.
16. Pahor, M.; Guralnik, J.M.; Ambrosius, W.T.; Blair, S.; Bonds, D.E.; Church, T.S.; Espeland, M.A.;

Fielding, R.A.; Gill, T.M.; Groessl, E.J.; et al. Effect of Structured Physical Activity on Prevention of Major Mobility Disability in Older Adults: The LIFE Study Randomized Clinical Trial. *JAMA* **2014**, *311*, 2387–2396, doi:10.1001/jama.2014.5616.

17. Arrieta, H.; Rezola-Pardo, C.; Zarrazquin, I.; Echeverria, I.; Yanguas, J.J.; Iturburu, M.; Gil, S.M.; Rodriguez-Larrad, A.; Irazusta, J. A Multicomponent Exercise Program Improves Physical Function in Long-Term Nursing Home Residents: A Randomized Controlled Trial. *Exp. Gerontol*. **2018**, *103*, 94–100, doi:10.1016/j.exger.2018.01.008.
18. Timonen, L.; Rantanen, T.; Ryynanen, O.P.; Taimela, S.; Timonen, T.E.; Sulkava, R. A Randomized Controlled Trial of Rehabilitation After Hospitalization in Frail Older Women: Effects on Strength, Balance and Mobility. *Scand. J. Med. Sci. Sports* **2002**, *12*, 186–192, doi:10.1034/j.1600-0838.2002.120310.x.
19. Stevens-Lapsley, J.E.; Loyd, B.J.; Falvey, J.R.; Figiel, G.J.; Kittelson, A.J.; Cumbler, E.U.; Mangione, K.K. Progressive Multi-Component Home-Based Physical Therapy for Deconditioned Older Adults Following Acute Hospitalization: A Pilot Randomized Controlled Trial. *Clin. Rehabil*. **2016**, *30*, 776–785, doi:10.1177/0269215515603219.
20. Martinez-Velilla, N.; Casas-Herrero, A.; Zambom-Ferraresi, F.; Lopez Saez de Asteasu, M.; Lucia, A.; Galbete, A.; Garcia-Baztan, A.; Alonso-Renedo, J.; Gonzalez-Glaria, B.; Gonzalo-Lazaro, M.; et al. Effect of Exercise Intervention on Functional Decline in very Elderly Patients during Acute Hospitalization: A Randomized Clinical Trial. *JAMA Intern. Med*. **2018**, doi:10.1001/jamainternmed.2018.4869.
21. Saez de Asteasu, M.L.; Martinez-Velilla, N.; Zambom-Ferraresi, F.; Casas-Herrero, A.; Cadore, E.L.; Galbete, A.; Izquierdo, M. Assessing the Impact of Physical Exercise on Cognitive Function in Older Medical Patients during Acute Hospitalization: Secondary Analysis of a Randomized Trial. *PLoS Med*. **2019**, *16*, e1002852, doi:10.1371/journal.pmed.1002852.
22. Benzo, R.; Wetzstein, M.; Neuenfeldt, P.; McEvoy, C. Implementation of Physical Activity Programs After COPD Hospitalizations: Lessons from a Randomized Study. *Chron. Respir. Dis*. **2015**, *12*, 5–10, doi:10.1177/1479972314562208.
23. Ruano-Ravina, A.; Pena-Gil, C.; Abu-Assi, E.; Raposeiras, S.; van't Hof, A.; Meindersma, E.; Bossano Prescott, E.I.; Gonzalez-Juanatey, J.R. Participation and Adherence to Cardiac Rehabilitation Programs. A Systematic Review. *Int. J. Cardiol*. **2016**, *223*, 436–443, doi:10.1016/j.ijcard.2016.08.120.
24. Mudge, A.M.; Denaro, C.P.; Scott, A.C.; Meyers, D.; Adsett, J.A.; Mullins, R.W.; Suna, J.M.; Atherton, J.J.; Marwick, T.H.; Scuffham, P.; et al. Addition of Supervised Exercise Training to a Post-Hospital Disease Management Program for Patients Recently Hospitalized with Acute Heart Failure: The EJECTION-HF Randomized Phase 4 Trial. *JACC Heart Fail*. **2018**, *6*, 143–152, doi:10.1016/j.jchf.2017.11.016.
25. Back, M.; Jivegard, L.; Johansson, A.; Nordanstig, J.; Svanberg, T.; Adania, U.W.; Sjogren, P. Home-Based Supervised Exercise Versus Hospital-Based Supervised Exercise or Unsupervised Walk Advice as Treatment for Intermittent Claudication: A Systematic Review. *J. Rehabil. Med*. **2015**, *47*, 801–808, doi:10.2340/16501977-2012.
26. Deer, R.R.; Dickinson, J.M.; Fisher, S.R.; Ju, H.; Volpi, E. Identifying Effective and Feasible Interventions to Accelerate Functional Recovery from Hospitalization in Older Adults: A Randomized Controlled Pilot Trial. *Contemp. Clin. Trials* **2016**, *49*, 6–14, doi:10.1016/j.cct.2016.05.001.
27. Lacroix, A.; Kressig, R.W.; Muehlbauer, T.; Gschwind, Y.J.; Pfenninger, B.; Bruegger, O.; Granacher, U. Effects of a Supervised versus an Unsupervised Combined Balance and Strength Training Program on Balance and Muscle Power in Healthy Older Adults: A Randomized Controlled Trial. *Gerontology.* **2016**, *62*, 275–288, doi:10.1159/000442087.
28. Tsekoura, M.; Billis, E.; Tsepis, E.; Dimitriadis, Z.; Matzaroglou, C.; Tyllianakis, M.; Panagiotopoulos, E.; Gliatis, J. The Effects of Group and Home-Based Exercise Programs in Elderly with Sarcopenia: A Randomized Controlled Trial. *J. Clin. Med*. **2018**, *7*, 480,

doi:10.3390/jcm7120480.
29. Hill, K.D.; Hunter, S.W.; Batchelor, F.A.; Cavalheri, V.; Burton, E. Individualized Home-Based Exercise Programs for Older People to Reduce Falls and Improve Physical Performance: A Systematic Review and Meta-Analysis. *Maturitas* **2015**, *82*, 72–84, doi:10.1016/j.maturitas.2015.04.005.
30. Sherrington, C.; Lord, S.R.; Vogler, C.M.; Close, J.C.T.; Howard, K.; Dean, C.M.; Heller, G.Z.; Clemson, L.; O'Rourke, S.D.; Ramsay, E.; et al. A Post-Hospital Home Exercise Program Improved Mobility but Increased Falls in Older People: A Randomised Controlled Trial. *PLoS ONE* **2014***, 9*, e104412, doi:10.1371/journal.pone.0104412.
31. Deer, R.R.; Dickinson, J.M.; Baillargeon, J.; Fisher, S.R.; Raji, M.; Volpi, E. A Phase I Randomized Clinical Trial of Evidence-Based, Pragmatic Interventions to Improve Functional Recovery After Hospitalization in Geriatric Patients. *J. Gerontol. Ser. A* **2019**, doi:10.1093/gerona/glz084.
32. DeVito, C.A.; Morgan, R.O.; Duque, M.; Abdel-Moty, E.; Virnig, B.A. Physical Performance Effects of Low-Intensity Exercise among Clinically Defined High-Risk Elders. *Gerontology* **2003**, *49*, 146–154, doi:10.1159/000069168.
33. Kosse, N.M.; Dutmer, A.L.; Dasenbrock, L.; Bauer, J.M.; Lamoth, C.J. Effectiveness and Feasibility of Early Physical Rehabilitation Programs for Geriatric Hospitalized Patients: A Systematic Review. *BMC Geriatr.* **2013**, *13*, 107, doi:10.1186/1471-2318-13-107.
34. Lacroix, A.; Hortobagyi, T.; Beurskens, R.; Granacher, U. Effects of supervised vs. unsupervised training programs on balance and muscle strength in older adults: A systematic review and meta-analysis. *Sports Med*. **2017**, *47*, 2341–2361, doi:10.1007/s40279-017-0747-6.
35. Folstein, M.F.; Folstein, S.E.; McHugh, P.R. "Mini-Mental State". A Practical Method for Grading the Cognitive State of Patients for the Clinician. *J. Psychiatr. Res*. **1975**, *12*, 189–198, doi:10.1016/0022-3956(75)90026-6.
36. Rodriguez-Larrad, A.; Arrieta, H.; Rezola, C.; Kortajarena, M.; Yanguas, J.J.; Iturburu, M.; Susana, M.G.; Irazusta, J. Effectiveness of a Multicomponent Exercise Program in the Attenuation of Frailty in Long-Term Nursing Home Residents: Study Protocol for a Randomized Clinical Controlled Trial. *BMC Geriatr*. **2017**, *17*, 60, doi:10.1186/s12877-017-0453-0.
37. Chodzko-Zajko, W.J. Exercise and Physical Activity for Older Adults. *Kinesiol. Rev.* **2014**, *3*, 101–106, doi:10.1123/kr.2014-0043.
38. Nelson, M.E.; Rejeski, W.J.; Blair, S.N.; Duncan, P.W.; Judge, J.O.; King, A.C.; Macera, C.A.; Castaneda-Sceppa, C.; American College of Sports Medicine; American Heart Association. Physical Activity and Public Health in Older Adults: Recommendation from the American College of Sports Medicine and the American Heart Association. *Circulation* **2007**, *116*, 1094–1105, doi:10.1161/CIRCULATIONAHA.107.185650.
39. Brzycki, M. Strength Testing—Predicting a One-Rep Max from Reps-to-Fatigue. *J. Phys. Educ. Recreat. Danc.* **1993**, *64*, 88–90, doi:10.1080/07303084.1993.10606684.
40. Campbell, A.J.; Robertson, M.; Clare. Otago Exercise Programme to Prevent Falls in Older Adults. 2003. Available online: https://hfwcny.org/hfwcny-content/uploads/Otago_Exercise_Programme-Revised.pdf (accessed on 10 July 2019).
41. Izquierdo, M.; Casas-Herrero, A.; Zambom-Ferraresi, F.; Martínez-Velilla, N.; Alonso-Bouzón, C.; Rodríguez-Mañas, L. Multi-Component Physical Exercise Program VIVIFRAIL. 2017. Available online: http://www.vivifrail.com/images/recursos/EN-P.SANITARIOS-portadas-web.pdf (accessed on 10 July 2019).
42. Guralnik, J.M.; Ferrucci, L.; Pieper, C.F.; Leveille, S.G.; Markides, K.S.; Ostir, G.V.; Studenski, S.; Berkman, L.F.; Wallace, R.B. Lower Extremity Function and Subsequent Disability: Consistency Across Studies, Predictive Models, and Value of Gait Speed Alone Compared with the Short Physical Performance Battery. *J. Gerontol. A Biol. Sci. Med. Sci*. **2000**, *55*, 221, doi:10.1093/gerona/55.4.m221.
43. Fess, E.E. *Clinical Assessment Recommendations*, 2nd ed.; Casanova, J.S., Ed.; American Society of Hand Therapists: Chicago, IL, USA, 1992; pp. 41–45.

44. Berg, K.O.; Wood-Dauphinee, S.L.; Williams, J.I.; Maki, B. Measuring Balance in the Elderly: Validation of an Instrument. *Can. J. Public Health* **1992**, *83* (Suppl. 2), 7.
45. Bohannon, R.W.; Andrews, A.W.; Thomas, M.W. Walking Speed: Reference Values and Correlates for Older Adults. *J. Orthop. Sports Phys. Ther*. **1996**, *24*, 86–90, doi:10.2519/jospt.1996.24.2.86.
46. Rikli, R.E.; Jones, C.J. *Senior Fitness Test Manual*; Human Kinetics: Champaign IL, USA, 2013.
47. Freedson, P.S.; Melanson, E.; Sirard, J. Calibration of the Computer Science and Applications, Inc. Accelerometer. *Med. Sci. Sports Exerc.* **1998**, *30*, 777–781.
48. Badia, X.; Roset, M.; Montserrat, S.; Herdman, M.; Segura, A. The Spanish Version of EuroQol: A Description and its Applications. European Quality of Life Scale. *Med. Clin.* **1999***, 112* (Suppl. 1), 79–85.
49. Marfell-Jones, M.J.; Stewart, A.D.; de Ridder, J.H. *International Standards for Anthopometric Assessment*; International Society for the Advancement of Kinanthropometry: Wellington, New Zealand, 2012. Available online:Hdl.handle.net/11072/1510 (accessed on 10 July 2019).
50. Guigoz, Y.; Lauque, S.; Vellas, B.J. Identifying the Elderly at Risk for Malnutrition. the Mini Nutritional Assessment. *Clin. Geriatr. Med.* **2002**, *18*, 737–757, doi:10.1016/S0749-0690(02)00059-9.
51. Bakeman, R. Recommended Effect Size Statistics for Repeated Measures Designs. *Behav. Res. Methods.* **2005**, *37*, 379–384, doi:10.3758/BF03192707.
52. Hopkins, W.G.; Marshall, S.W.; Batterham, A.M.; Hanin, J. Progressive Statistics for Studies in Sports Medicine and Exercise Science. *Med. Sci. Sports Exerc.* **2009**, *41*, 3–13, doi:10.1249/MSS.0b013e31818cb278.
53. Vogler, C.M.; Sherrington, C.; Ogle, S.J.; Lord, S.R. Reducing Risk of Falling in Older People Discharged from Hospital: A Randomized Controlled Trial Comparing Seated Exercises, Weight-Bearing Exercises, and Social Visits. *Arch. Phys. Med. Rehabil*. **2009**, *90*, 1317–1324, doi:10.1016/j.apmr.2009.01.030.
54. Volpato, S.; Cavalieri, M.; Sioulis, F.; Guerra, G.; Maraldi, C.; Zuliani, G.; Fellin, R.; Guralnik, J.M. Predictive Value of the Short Physical Performance Battery Following Hospitalization in Older Patients. *J. Gerontol. A Biol. Sci. Med. Sci.* **2011**, *66*, 89–96, doi:10.1093/gerona/glq167.
55. Perera, S.; Mody, S.H.; Woodman, R.C.; Studenski, S.A. Meaningful Change and Responsiveness in Common Physical Performance Measures in Older Adults. *J. Am. Geriatr. Soc.* **2006**, *54*, 743–749, doi:10.1111/j.1532-5415.2006.00701.x.
56. Timmerman, K.L.; Dhanani, S.; Glynn, E.L.; Fry, C.S.; Drummond, M.J.; Jennings, K.; Rasmussen, B.B.; Volpi, E. A Moderate Acute Increase in Physical Activity Enhances Nutritive Flow and the Muscle Protein Anabolic Response to Mixed Nutrient Intake in Older Adults. *Am. J. Clin. Nutr.* **2012**, *95*, 1403–1412, doi:10.3945/ajcn.111.020800.
57. Blanc-Bisson, C.; Dechamps, A.; Gouspillou, G.; Dehail, P.; Bourdel-Marchasson, I. A Randomized Controlled Trial on Early Physiotherapy Intervention Versus Usual Care in Acute Care Unit for Elderly: Potential Benefits in Light of Dietary Intakes. *J. Nutr. Health Aging* **2008**, *12*, 395–399.
58. Dent, E.; Hoogendijk, E.O.; Visvanathan, R.; Wright, O.R.L. Malnutrition Screening and Assessment in Hospitalised Older People: A Review. *J. Nutr. Health Aging* **2019**, *23*, 431–441, doi:10.1007/s12603-019-1176-z.
59. Robins, L.M.; Brown, T.; Lalor, A.F.; Stolwyk, R.; McDermott, F.; Haines, T. Social Isolation, Physical Capacity, and Physical Activity in Older Community-Dwelling Adults Post-Hospitalization. *J. Aging Phys. Act*. **2018**, *26*, 204–213, doi:10.1123/japa.2016-0257.
60. Buffart, L.M.; Kalter, J.; Sweegers, M.G.; Courneya, K.S.; Newton, R.U.; Aaronson, N.K.; Jacobsen, P.B.; May, A.M.; Galvao, D.A.; Chinapaw, M.J.; et al. Effects and Moderators of Exercise on Quality of Life and Physical Function in Patients with Cancer: An Individual Patient Data Meta-Analysis of 34 RCTs. *Cancer Treat. Rev*. **2017**, *52*, 91–104, doi:10.1016/j.ctrv.2016.11.010.

4.3. Article 3:

Effects of Short and Long-Term Group-Based Multicomponent Exercise Interventions on Frailty and Sarcopenia: A Randomized Controlled Trial

Abstract: (1) Background: People with frailty and/or sarcopenia have an increased risk of negative health outcomes. Although both are considered reversible conditions, it is often difficult to know which features of physical activity/exercise programs would optimize the sustainability and efficacy of the intervention; (2) Methods: This study analyze and compare the effects of two multicomponent physical exercise interventions with different supervised group-based period lengths on frailty and sarcopenia among post-hospitalized older adults. Participants were randomly assigned to either a short-term group-based branch (SGB) or a long-term group-based branch (LGB). The SGB consisted of 6-week of supervised group sessions in the hospital and 6-week of individual sessions at home. The LGB undertook a 12-week group exercise session in the hospital. Frailty status and sarcopenia were assessed at baseline and at 3 months with Fried´s Index and revised EWGSOP cut-off points; (3) Results: Regarding changes within groups, both groups reduced Fried's Index after 3-month intervention (paired student's t-test, $p<0.01$). Percentage of patients with confirmed sarcopenia tended to improve in both, but there was no significant effect on sarcopenia. No group-by-time interaction was observed; (4) Conclusions: Based on these findings, we determined that a six-week group-based multicomponent exercise intervention is sufficient to reverse frailty in the post-hospitalization period. Further studies using larger samples are warranted to clarify the effect of treatment and prevention of sarcopenia.

Keywords: frailty; sarcopenia; hospitalization; multicomponent; group-based; home-based

1. Introduction

In the last few years, as the population ages, health policy and research in aging have focused on frailty and sarcopenia [Dent et al., 2016; Tan et al., 2017; Sicsic et al., 2020]. Frailty is considered an age-related syndrome which leaves older adults more vulnerable when facing minor stressors [Dent et al., 2016] and, consequently, exposes them to a higher risk of adverse health-related events such as falls, hospitalization and even death [Fried et al., 2001]. Meantime, sarcopenia is a progressive and generalized skeletal muscle disorder involving accelerated loss of muscle mass and physical function [Cruz-Jentoft and Sayer 2019], which like frailty increases the risk of adverse events. Even though, both conditions have several characteristics in common: highly prevalent in the elderly, associated with negative health-related events, relatively easy to diagnose in the clinical practice… [Cesari et al., 2014], there are small, but significant, differences between them [Calvani et al., 2019]. The main difference is that low muscle mass is a central factor for identifying sarcopenia, but not frailty, which is also defined by behavioural and mood-related variables [Lopes-Cunha et al., 2019]. Both models have an overlap in the physical component [Cruz-Jentoft et al., 2017]; hence, they are characterized by a unique condition, the physical function impairment [Cesari et al., 2014; Billot et al., 2020].

A growing body of evidence suggests that physical activity and exercise interventions are the most promising to remedy frailty [Cadore et al., 2013; Cadore et al., 2014; Fried et al., 2021] and sarcopenia [Yoshimura et al., 2017; Yoo et al., 2018]. In consequence, physical activity/exercise programs are proposed as an effective countermeasure to frailty and sarcopenia [Marzetti et al., 2017; Nascimento et al., 2019; Billot et al., 2020]. Multicomponent physical exercise programs including strength, endurance and balance training are widely recommended in the literature, because exercise programs have multisystem effects and positive effects are more often observed when more than one physical condition comprises the training [Cadore et al., 2013; Cadore et al., 2014; Nascimento et al., 2019; Billot et al., 2020; Fried et al., 2021]. Nevertheless, still exists uncertainty regarding to exercise characteristics such as type, duration, setting, frequency, intensity et cetera [Giné-Garriga et al., 2014; Moore et al., 2020; Billot et al., 2020]. Usually, the greater the intensity of supervision, the greater the improvements tend to be, but as mentioned above there is no consensus on which programs provide the greatest improvements in older adults [Sherrington et al., 2014; Deer et al., 2019]. Some important factors regarding exercise are whether it is performed individually (home-based) or in a group (group-based) [Clegg et al., 2012; Tsekoura et al., 2018; Billot et al., 2020]. It remains also unclear what is the most efficient program duration [Wang et al., 2020]. In some programs, after the initial supervised sessions, there is a period of home-based sessions to facilitate performance and adherence. Thus, these programs

take advantage of both interventions, group- and home-based. In fact, in the long-term, more positive on functional parameters effects were found when there was a follow-up at home or in a community after completion of a group-based intervention [Kosse et al., 2013; Kanach et al., 2018]. Therefore, to evaluate graded approaches, interventions with different stages of exercise supervision have been implemented [Lacroix et al., 2017].

Hospitalizations can be related to both frailty and sarcopenia. Frailty syndrome is highly prevalent among hospitalized older adults [Aranha et al., 2020] and sarcopenia might appear acutely during hospital admission, especially in older adults [Cruz-Jentoff and Sayer 2019]. Since frailty [O'Brien et al., 2018] and sarcopenia [Yoo et al., 2018] are also associated with an increased risk of hospital admissions/readmission, the link between hospitalizations and frailty/sarcopenia might lead to a vicious cycle which can reduce physical and cognitive function, increased disability, loss of independence and mortality and reduced quality of life [Tan et al., 2017; Yilmaz et al., 2019]. Both, frailty and sarcopenia, are considered reversible conditions [Cesari et al., 2014; Guglielmi et al., 2016], good predictors of multiple adverse health outcomes [Tan et al., 2017] and in combination are more predictive of mortality than either condition alone [Thompson et al., 2021]. Therefore, their early detection is of the utmost importance for their treatment, but there is a notable paucity of high quality research in the literature investigating the effects of exercise for frailty [Han et al., 2020] or sarcopenia [Yoshimura et al., 2017; Wang et al., 2020] during or after hospitalization [Beckwée et al., 2019; Han et al., 2020; Wang et al., 2020]. Recent research has shown that multicomponent programs can be safe and effective in preventing physical and cognitive decline in hospitalized pre-frail and frail older adults [Matinez-velilla et al., 2019]. This type of intervention has also been shown to be the most effective in delaying disability, as well as effective in reversing functional decline associated with acute hospitalization in very elderly patients [Matinez-velilla et al., 2019]. Other exercise interventions have improved the activities of daily living, strength and physical performance among older sarcopenic patients in post-acute care settings [Liang et al., 2020]. However, most of the studies that have been conducted were performed with hospitalized or community-dwelling older adults [Yoshimura et al., 2017; Moore et al., 2019; Wang et al., 2020] and comparing intervention group with control group. Fewer studies were performed after hospitalization and most of them were carried out with patients undergoing cardiac or lung pathologies and after hip or knee repair [Bulthuis et al., 2007; Benzo et al., 2015; Mudge et al., 2018; Anker and Coats 2021; Sanchis et al., 2021]. A clear example of the lack of studies regarding physical exercise after hospitalization is the recent meta-analysis of interventions in pre-frail or frail adults where it was clarified that three studies had inpatient only interventions, five had

interventions that extended from inpatient to post-discharge, and two studies offered intervention only post-discharge [Han et al., 2020].

Thus, we aimed to analyze and compare the effects of two multicomponent physical exercise interventions with different supervised group-based period lengths on frailty and sarcopenia among older adults after hospitalization.

2. Materials and Methods

2.1. Study Design

This was an experimental and single-blinded randomized controlled intervention study (ACTRN12619000093189). The study was approved by the Committee on Ethics in Research at the University Hospital of Araba (CEIC-HUA Code Expte. 2017-021). Participants were randomly assigned to either a short-term group-based branch (SGB) or a long-term group-based branch (LGB). The SGB consisted of 6-week of group sessions supervised in the hospital and 6-week of individual sessions at home. The LGB undertook a 12-week group exercise session supervised in the hospital. Written informed consent was obtained from all study participants before enrollment in the study. The study sample comprised patients aged 70 years or older, who scored at least 20 on the Mini Mental State Examination (MMSE) [Folstein et al., 1975], and were able to walk (with or without assistive devices) independently for at least 4m. Participants were not eligible for the study if they met any of the following criteria: a diagnosis of chronic kidney disease (eGFR <30 ml/min), severe dementia, autoimmune neuromuscular disease, acute myocardial infarction or a bone fracture in the last three months. Participants were randomly assigned (in a 1:1 ratio) using sealed opaque envelopes to either the SGB or LGB by coin-toss sequence generation.

2.2. Group-Based and Home-Based Interventions

Participants in both branches during supervised period (group sessions) performed two sessions per week lasting approximately an hour each. The group-based intervention consisted of multicomponent physical exercise sessions designed to improve strength, power, balance, and walking conducted by experienced physical trainers. During unsupervised period (individual sessions) each participants have a week schedule that consisted of five days of multicomponent exercises and seven days of walking recommendations. Exercises were learned during the group sessions. A full description of the progression of repetitions, intensity and types of strength and balance exercises has been previously published [Echeverria et al., 2020].

2.3. Outcomes

We previously described the effects of SGB and LGB interventions on physical function, physical activity, quality of life, nutritional status and anthropometry in older adults after hospitalization [Echeverria et al, 2020]. In addition, we have also previously

published possible reasons for refusing a post-discharge exercise program [Urquiza et al., 2020].

Patient demographic (sex and age) and MMSE data were retrieved from the Basque Public Health Service's database. Anthropometry measurements were obtained before functional assessments by an experienced nutritionist. Height was measured with a Seca213 stadiometer to the nearest 0.1 cm, and body mass was measured with an OmronHN288 digital scale to the nearest 0.1 kg. Accordingly, body mass index (BMI) was calculated as body weight divided by height squared (kg/m2).

Frailty status and sarcopenia were assessed at baseline and at 3 months with Fried´s Index and revised EWGSOP cut-off points. Fried's index evaluates the presence of 5 criteria: unintentional weight loss, exhaustion, low physical activity, slow walking speed (slowness) and weakness (reduced grip strength). Individuals are considered frail when they meet 3 or more criteria out of the 5 [Fried et al., 2001]. The revised cut-off points proposed by EWGSOP2 were used for the assessment of sarcopenia. Hence, participants with low grip strength (<27 kg for men and <16 kg for women), or those who needed more than 15 seconds to complete 5 rises in the Chair Stand Test (CST), were classified as candidates for sarcopenia. Sarcopenia was confirmed when the Appendicular skeletal muscle mass (ASM) was lower than 5.5 kg/m2 for women and 7.0 kg/m2 for men [Cruz-Jentoft et al., 2019]. ASM was assessed by DXA (HOLOGIC, QDR 4500).

2.4. Statistical Analyses

Qualitative data are presented as percentages and quantitative data are presented as mean ± SD. Normal distribution of quantitative data was determined by the Shapiro–Wilk test. When data were not normally distributed, values were square-root transformed. Chi-squared test and unpaired t-test were used to compare the two groups at baseline. Group-by-time differences in Fried index score were assessed using mixed design analysis of variance (ANOVA; two time points x two groups) with two levels (baseline and 3 months). Eta squared ($\eta 2$) was calculated to estimate the effect size. Values for $\eta 2$ of ≤0.02, ≤0.13, ≥013, and ≥0.26 were considered small, medium, medium-large and large, respectively [Bakeman, 2005]. Comparisons of the changes within each group were performed with paired Student's t-tests. Thresholds of 0.1, 0.3, 0.5, 0.7, and 0.9 were used for small, moderate, large, very large, and extremely large effects, respectively, as suggested by Cohen [Hopkins, 2009]. Relationships between categorical variables (contingency tables) were determined by a chi-square test (McNemar). McNemar's test was also used to compare confirmed sarcopenia and Fried´s index of both groups between different periods.

The significance level for all tests was $p < 0.05$. Statistical analysis was performed using the IBM SPSS Statistics 24 statistical software package (SPSS, Inc., Chicago, IL, USA).

3. Results

We recruited 55 participants (26 women and 29 men) from the Internal Medicine and Neurology services of the University Hospital of Araba (HUA Of the 55 patients that were initially enrolled, the mean age was 82.6 years, and 52.7% of participants were men. A flow diagram describing the recruitment of participants is shown in Figure 1; finally, 27 patients were assigned to the SGB and 28 to the LGB. Baseline characteristics were not significantly different between SGB and LGB (Table 1).

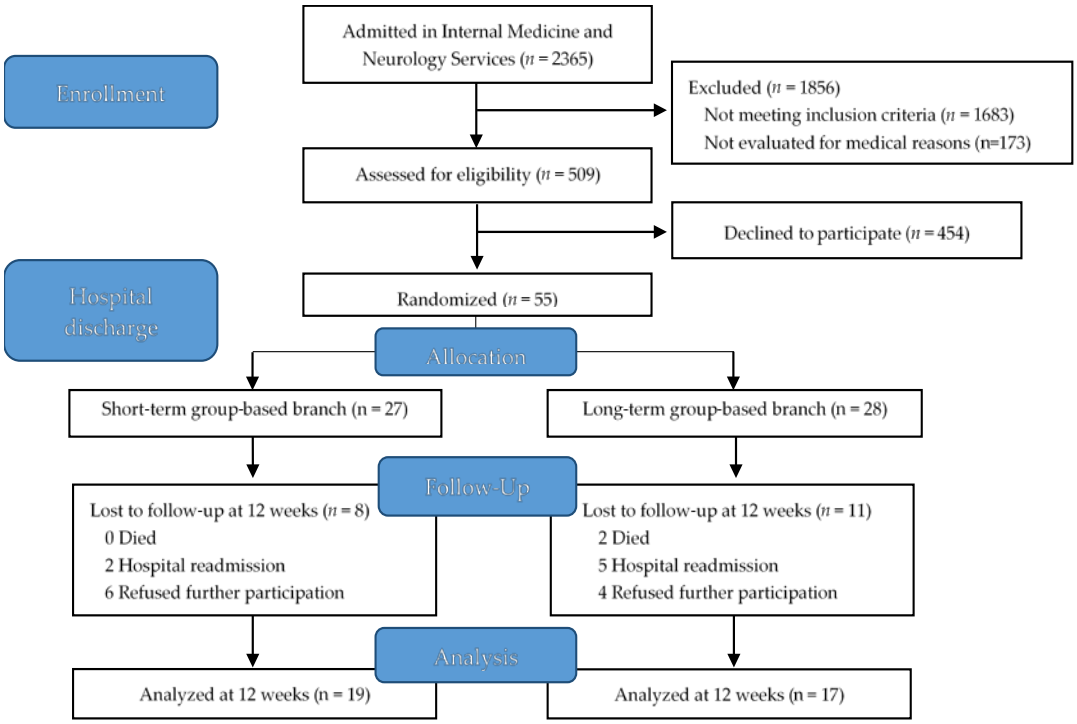


Figure 1. Flow diagram of participant selection.

Table 1. Descriptive characteristics of study participants

	RANDOMIZED	SGB	LGB
Age (years), mean ± SD	82.58 ± 5.7 (n = 55)	82.9 ± 5.7 (n = 27)	82.26 ± 5.5 (n = 28)
Sex, n (%)			
Female	26 (47.3%)	13 (48.15)	13 (46.43)
Male	29 (52.7%)	14 (51.85)	15 (53.57)
MMSE (0–30), mean ± SD	25.15 ± 2.8 (n = 55)	25.2 ± 2.3 (n = 27)	25.1 ± 3.3 (n = 28)
Body height (cm), mean ± SD	158.5 ± 8.45 (n = 55)	158.8 ± 8.4 (n = 27)	158.2 ± 8.5 (n = 28)
Weight (kg), mean ± SD	72.02 ± 16.22 (n = 50)	69.92 ± 14.45 (n = 25)	74.12 ± 17.99 (n = 25)
Body mass index (kg/m2), mean ± SD	28.73 ± 6.49 (n = 50)	27.95 ± 6.64 (n = 25)	29.51 ± 6.34 (n = 25)
Frail, n (%)	33 (63.47%)	16 (64%)	17 (62.97%)
Sarcopenic, n (%)	12 (24.49%)	5 (20.83%)	7 (28%)

SGB = short-term group-based branch; LGB = long-term group-based branch; MMSE = Mini Mental State Examination

3.2. Adherence and compliance

Mean attendance rates for the group-based exercise sessions were 88.7%, and compliance for the walking recommendations was 89.0%. During the home-based period, the SGB performed the 82.3% of the sessions. No adverse effects of exercise occurred. Of the 55 patients that were initially enrolled, 19 (SGB = 8 and LGB = 11) were lost to follow-up before the 12-week time point. The main reasons were three: death, hospital readmission, and refused further participation.

3.3. Frailty Status

If we analyzed the participants of both groups together, i.e., the randomized participants, we observe a significant improvement in the Fried's Index ($p < 0.001$; Cohen's d = extremely large) during the interventions. Furthermore, if we focus on the percentage of people with frailty status (Pre N:23; Post N:3), while at the beginning of the program 63.9% were frail at the end of the multicomponent exercises we end up with only 8.3% of frail participants ($p < 0.001$). Moreover, taking into account each evaluation criteria of Fried´s index, we obtained a significant improvement in four of them (Table 2)

Regarding changes within groups, both groups reduced Fried's frailty index (SGB $p < 0.001$; Cohen's d = extremely large, and LGB $p < 0.001$; Cohen's d = extremely large) and the percentage of people with frailty status (SGB $p < 0.002$ and LGB $p < 0.001$) during the intervention. When results were analyzed in terms of each one of the five criteria of frailty, the SGB improved significantly in exhaustion and activity level while the LGB tended to improve in both, but it did not reach statistical significance. Both groups improved significantly in the slowness criteria and neither in the weight lost and weakness criteria (Table 2).

Fried's Index showed no significantly differences between SGB and LGB before the intervention ($p < 0.001$; η 2 = small). In addition, there was not significant group–time interaction in the attenuation of frailty assessed by Fried's Index ($p > .05$). However, there was not significant difference in the prevalence of frailty between LGB and SGB according to Fried's Index after the 3-month intervention period. The only significant group*time interaction in favor of the LGB, was found in the changes of the percentage of participants who met the slowness gait criterion of frailty ($p = .035$) (Table 2).

Table 2. Analysis of frailty status and each criteria at 0 (pre) and 12 (post) weeks.

	RANDOMIZED			SGB			LGB			η 2
	PRE	**POST**	**Cohen's d**	**PRE**	**POST**	**Cohen's d**	**PRE**	**POST**	**Cohen's d**	
Fried´s Index, mean ± SD	2.81 ± 1.35	1.11 ± 1.01	1.428***	2.89 ± 1.3	1.26 ± 1.5	1.162***	2.65 ± 1.3	0.94 ± 0.83	1.55***	0.001
	RANDOMIZED			**SGB**			**LGB**			**Mc**
	PRE	**POST**	**p. Value**	**PRE**	**POST**	**p. Value**	**PRE**	**POST**	**p. Value**	**Nemar**
Frailty Status										
Frail % (n)	63.89% (23)	8.33% (3)	.001#	68.42% (13)	15.79% (3)	.002#	58.82% (10)	0% (0)	.001#	.092
Weight Lost										
Yes % (n)	27.78% (10)	5.56% (2)	.008#	21.05% (4)	5.26% (1)	.250#	35.29 % (6)	5.88% (1)	.063#	.125
Exhaustion										
Yes % (n)	55.56% (20)	13.89% (5)	.001#	68.42% (13)	15.79% (3)	.002#	41.17% (7)	11.77% (2)	.063#	.344
Low activity level										
Yes % (n)	44.44% (16)	11.11% (4)	.001#	57.89% (11)	15.79% (3)	.008#	29.41% (5)	5.88% (1)	.219#	.727
Slowness										
Yes % (n)	63.89% (23)	11.11% (4)	.002#	57.89% (11)	15.79% (3)	.008#	70.59% (12)	5.88% (1)	.001#	.035
Weakness										
Yes % (n)	86.11% (31)	69.44% (25)	.070#	84.21% (16)	73.68% (14)	.625#	88.23% (15)	64.71% (11)	.125#	1.000

SGB = short-term group-based branch; LGB = long-term group-based branch; *** $p < 0.001$; #McNemar

3.4. Sarcopenia

When LGB and SGB groups were analyzed together, there was also a trend to decline the percentage of patients on confirmed sarcopenia (Pre N: 8; Post N: 3) after 3 months. If we focus on both criteria to classify participants as candidates for sarcopenia, we observed a significant improvement in one of them. That is, the percentage of sarcopenics assessed by 5-SQUAT goes from 30.3% to 3%. No significant improvement was observed for handgrip and DXA criteria (Table 3).

After the intervention, no statistically significant group–time interaction between LGB and SGB in the percentage of participants with sarcopenia was observed (McNemar for the interaction group x time and within groups, $p > .05$). However, a positive trend was observed in LGB intervention. When results were analyzed in terms of each one of the 3 criteria of sarcopenia, both groups improved in sit to stand five times criteria but it did not reach statistical significance. No significant improvement was observed in the other two criteria (handgrip and DXA) (Table 3).

Table 3. Analysis of sarcopenia and each criteria at 0 (pre) and 12 (post) weeks.

	RANDOMIZED			SGB			LGB			Mc
	PRE	**POST**	**p. Value**	**PRE**	**POST**	**p. Value**	**PRE**	**POST**	**p. Value**	**Nemar**
Sarcopenia Confirmed										
Sarcopenic % (n)	24.24% (8)	9.09% (3)	.063#	12.50% (2)	6.25% (1)	1.000#	35.29% (6)	11.77% (2)	.125#	.125
HandGrip										
Sarcopenic % (n)	30.56% (11)	27.78% (10)	.100#	21.05% (4)	31.58% (6)	.500#	41.17% (7)	23.53% (4)	.250#	1.000
5-SQUAT										
Sarcopenic % (n)	30.30% (10)	3.03% (1)	.004#	68.42% (5)	0% (0)	.063#	29.41% (5)	5.88% (1)	.125#	.063
DXA										
Sarcopenic % (n)	19.23% (5)	15.38% (4)	.100#	25% (4)	18.75% (3)	1.000#	10% (1)	10% (1)	1.000#	.625

SGB = short-term group-based branch; LGB = long-term group-based branch; 5-SQUAT sit-to-stand five times; DXA Dual X-ray absorptiometry; ; *** $p < 0.001$; #McNemar

4. Discussion

In the present study, both multicomponent physical exercise intervention programs implemented at hospital discharge provided significant and equivalent benefits on frailty. Our interventions have demonstrated to be safe for post-hospitalized older patients. The results also suggest that a six-week group-based multicomponent exercise intervention is sufficient to reverse frailty as we previously described in functional and nutritional decline associated with hospitalization [Echeverria et al., 2020].

Both interventions implemented in the current study drastically reduced the incidence of frailty. At the beginning of the intervention, 23 out of 36 patients were frail, according to Fried´s Frailty Index and at the end, only 3 of them maintained frail status. The number of patients who fulfill each of frailty criteria also decreased during the intervention, being the decrease significant in exhaustion, slowness and low activity for SGB and in slowness in LGB. Accordingly, the averages of the Fried´s index were also reduced throughout 12 weeks by 56% and 64% in SGB and LGB respectively.

Frailty is a complex multisystem syndrome that profoundly alters the patient's ability to recover from acute trauma [De Biasio et al., 2020]. Illness and hospitalizations likely contribute not only to short-term changes in functional capacity, but also to long-term changes that could threaten the functional independence of older adults, increasing pre-frail and frail states [Gill et al., 2011]. Pre-frail and frail elderly are particularly vulnerable to adverse effects of hospitalization, especially functional decline [Merchant et al., 2021]. This decline in capacities may continue even months after discharge [Chen et al., 2008]. In this regard, a longitudinal study observed that at 3 months after discharge, patients' muscle mass, muscle strength and physical performance did not reach normative levels at the population level [Aarden et al., 2020]. Other studies described that the decline can remain even more than one year following hospital admission [Gill et al., 2010].

Physical training should be considered as a highly effective curative strategy to delay and attenuate the negative effects of sarcopenia and frailty in both early and late stages [Talar et al., 2021]. Several authors emphasize the need for well-designed, large-scale RCTs with validated definitions of frailty and sarcopenia, and standardized outcomes [Lozano-Montoya et al., 2017]. In other words, they reiterate that standardized screening for these conditions on hospital admission is highly warranted [Dent et al, 2016; Ligthart-Melis et al., 2020; Ruiz et al., 2020]. There are many methods of measuring frailty, with the one we have used, Fried's Frailty Phenotype, being a widely used tool to identify frailty [Dent et al., 2016] and reported in 70% of published articles [Bouillon et al., 2013]. The results of other studies also support the updated evidence-based guidelines on its definition and diagnosis of EWGSOP2 [Bertschi et al., 2021] with a focus on muscle strength as the key feature of sarcopenia [Ibrahim et al., 2019].

Our results demonstrated that frailty can be reversed in post-hospitalized patients. This effect is clinically relevant because attenuated frailty could reduce the risk of adverse events related to hospitalization such as re-hospitalizations, dependence, institutionalization and even death. Although we have not obtained between-group differences in the reduction of the prevalence of frailty, as described in previous publications on other physical variables [Echeverria et al., 2020], it is true that in favor LGB, there is a difference between the groups in the slowness (gait speed) criteria. This could be because the level of supervision seems to be relevant in home-based programs to obtain greater improvements in physical function [Lacroix et al., 2016; Tsekoura et al., 2018].

In sarcopenia, no significant improvements were obtained in either group. Our findings on sarcopenia are in line with a recent publication in which the authors concluded that the application of exercise programs seems to counteract some of the main effects of this syndrome, such as decreased strength and physical performance. However, the evidence is not yet sufficient to support an effect on muscle mass [Escriche-Escuder et al., 2021]. Exercise alone may not be enough; multimodal interventions that promote the combination multicomponent exercise programs with nutritional interventions may be more effective in the management sarcopenia [Cruz-Jentoft et al., 2017; Nascimento et al., 2019, Han et al., 2020]. In addition, we assessed changes in body composition by DXA and with this methodology, differences smaller than 1.0 kg are not detectable [Tieland et al., 2012]. If we focus on both criteria for classifying participants as candidates for sarcopenia, we observed a small difference in both groups. As occurred in the frailty assessment, no improvement in grip strength is achieved, but there is a positive trend of improvement in lower body strength. This may have been given that handgrip strength is not a clinically relevant and/or valid measurement for assessing changes in muscle function in response to a resistance-training program in older people [Bourdel-Marchasson et al., 2001; Leenders et al., 2013]. Multicomponent exercise could be effective at counteracting the decline in physical function for sarcopenia. However, it is unclear whether this type of exercise program is effective in increasing muscle mass among those with sarcopenia [Makizako et al., 2020 Escriche-Escuder et al., 2021]. Furthermore, in addition to this, we have a smaller sample size in the DXA measurement than in frailty assessment. Further studies with larger sample size may be needed to clarify the effect of treatment and prevention of age-related decline in muscle mass and strength related to aging and sarcopenia.

One of the strengths of the study is that, to the best of our knowledge, this is one of the first to compare and analyze frailty and sarcopenia with current and validated scales in two different lengths of group-based multicomponent exercise interventions at hospital discharge. These findings, coupled with previously published, are relevant to

design specific interventions in a hospital setting. In addition, the compliance with the interventions was good, both in group-based and in home-based, which supports the feasibility of this type of program. One of the main limitations of this study is that we were unable to determine the frailty status of the subjects before hospitalization and that we have not had a non-intervention group. In addition, the large number of screened participants who did not accept participation in the intervention limits this study. This may mean that the sample is small and not fully representative of older people recently discharged from the hospital.

5. Conclusions

Older adults recently discharged from hospitalization who participated in the two multicomponent exercise interventions evaluated in this randomized controlled trial obtained significant improvements on frailty but not in sarcopenia except for lower body function.

Furthermore, it was determined that 6-week of a supervised group exercise intervention caused similar or nearly equal benefits to those of a longer 12-week supervised group intervention. These results provide valuable information for the design of practical and feasible physical exercise interventions after hospitalization in older adults. In addition, it has been shown that frail and sarcopenic population is capable of responding to an exercise program whether in a group-based or a home-based setting.

References

Dent, E., Kowal, P., & Hoogendijk, E. O. (2016). Frailty measurement in research and clinical practice: A review. *European journal of internal medicine*, *31*, 3–10. https://doi.org/10.1016/j.ejim.2016.03.007

Tan, L. F., Lim, Z. Y., Choe, R., Seetharaman, S., & Merchant, R. (2017). Screening for Frailty and Sarcopenia Among Older Persons in Medical Outpatient Clinics and its Associations With Healthcare Burden. *Journal of the American Medical Directors Association*, *18*(7), 583–587. https://doi.org/10.1016/j.jamda.2017.01.004

Sicsic, J., Ravesteijn, B., Rapp, T., & SPRINT-T consortium (2020). Are frail elderly people in Europe high-need subjects? First evidence from the SPRINTT data. *Health policy (Amsterdam, Netherlands)*, *124*(8), 865–872. https://doi.org/10.1016/j.healthpol.2020.05.009

Fried, L. P., Tangen, C. M., Walston, J., Newman, A. B., Hirsch, C., Gottdiener, J., Seeman, T., Tracy, R., Kop, W. J., Burke, G., McBurnie, M. A., & Cardiovascular Health Study Collaborative Research Group (2001). Frailty in older adults: evidence for a phenotype. *The journals of gerontology. Series A, Biological sciences and medical sciences*, *56*(3), M146–M156. https://doi.org/10.1093/gerona/56.3.m146

Cruz-Jentoft, A. J., & Sayer, A. A. (2019). Sarcopenia. *Lancet (London, England)*, *393*(10191), 2636–2646. https://doi.org/10.1016/S0140-6736(19)31138-9

Cesari, M., Landi, F., Vellas, B., Bernabei, R., & Marzetti, E. (2014). Sarcopenia and physical frailty: two sides of the same coin. *Frontiers in aging neuroscience*, *6*, 192. https://doi.org/10.3389/fnagi.2014.00192

Calvani, R., Picca, A., Landi, F., Cesari, M., & Marzetti, E. (2019). In reply to "Small, however significant differences in the definition of physical frailty and sarcopenia". *European journal of internal medicine*, *61*, e10–e11. https://doi.org/10.1016/j.ejim.2019.01.007

Cunha, A., Veronese, N., de Melo Borges, S., & Ricci, N. A. (2019). Frailty as a predictor of adverse outcomes in hospitalized older adults: A systematic review and meta-analysis. *Ageing research reviews*, *56*, 100960. https://doi.org/10.1016/j.arr.2019.100960

Cruz-Jentoft, A. J., Kiesswetter, E., Drey, M., & Sieber, C. C. (2017). Nutrition, frailty, and sarcopenia. *Aging clinical and experimental research*, *29*(1), 43–48. https://doi.org/10.1007/s40520-016-0709-0

Billot, M., Calvani, R., Urtamo, A., Sánchez-Sánchez, J. L., Ciccolari-Micaldi, C., Chang, M., Roller-Wirnsberger, R., Wirnsberger, G., Sinclair, A., Vaquero-Pinto, N., Jyväkorpi, S., Öhman, H., Strandberg, T., Schols, J., Schols, A., Smeets, N., Topinkova, E., Michalkova, H., Bonfigli, A. R., Lattanzio, F., … Freiberger, E. (2020). Preserving Mobility in Older Adults with Physical Frailty and Sarcopenia: Opportunities, Challenges, and Recommendations for Physical Activity Interventions. *Clinical interventions in aging*, *15*, 1675–1690. https://doi.org/10.2147/CIA.S253535

Cadore, E. L., Rodríguez-Mañas, L., Sinclair, A., & Izquierdo, M. (2013). Effects of different exercise interventions on risk of falls, gait ability, and balance in physically frail older adults: a systematic review. *Rejuvenation research*, *16*(2), 105–114. https://doi.org/10.1089/rej.2012.1397

Cadore, E. L., Pinto, R. S., Bottaro, M., & Izquierdo, M. (2014). Strength and endurance training prescription in healthy and frail elderly. *Aging and disease*, *5*(3), 183–195. https://doi.org/10.14336/AD.2014.0500183

Fried, L.P., Cohen, A.A., Xue, QL. *et al.* The physical frailty syndrome as a transition from homeostatic symphony to cacophony. *Nat Aging* **1**, 36–46 (2021). https://doi.org/10.1038/s43587-020-00017-z

Yoshimura, Y., Wakabayashi, H., Yamada, M., Kim, H., Harada, A., & Arai, H. (2017). Interventions for Treating Sarcopenia: A Systematic Review and Meta-Analysis of Randomized Controlled Studies. *Journal of the American Medical Directors Association*, *18*(6), 553.e1–553.e16. https://doi.org/10.1016/j.jamda.2017.03.019

Yoo, S. Z., No, M. H., Heo, J. W., Park, D. H., Kang, J. H., Kim, S. H., & Kwak, H. B. (2018). Role of exercise in age-related sarcopenia. *Journal of exercise rehabilitation*, *14*(4), 551–558. https://doi.org/10.12965/jer.1836268.134

Marzetti, E., Calvani, R., Tosato, M., Cesari, M., Di Bari, M., Cherubini, A., Broccatelli, M., Savera, G., D'Elia, M., Pahor, M., Bernabei, R., Landi, F., & SPRINTT Consortium (2017). Physical activity and exercise as countermeasures to physical frailty and sarcopenia. *Aging clinical and experimental research*, *29*(1), 35–42. https://doi.org/10.1007/s40520-016-0705-4

Nascimento, C. M., Ingles, M., Salvador-Pascual, A., Cominetti, M. R., Gomez-Cabrera, M. C., & Viña, J. (2019). Sarcopenia, frailty and their prevention by exercise. *Free radical biology & medicine*, *132*, 42–49. https://doi.org/10.1016/j.freeradbiomed.2018.08.035

Giné-Garriga, M., Roqué-Fíguls, M., Coll-Planas, L., Sitjà-Rabert, M., & Salvà, A. (2014). Physical exercise interventions for improving performance-based measures of physical function in community-dwelling, frail older adults: a systematic review and meta-analysis. *Archives of physical medicine and rehabilitation*, *95*(4), 753–769.e3. https://doi.org/10.1016/j.apmr.2013.11.007

Moore, S. A., Hrisos, N., Errington, L., Rochester, L., Rodgers, H., Witham, M., & Sayer, A. A. (2020). Exercise as a treatment for sarcopenia: an umbrella review of systematic review evidence. *Physiotherapy*, *107*, 189–201. https://doi.org/10.1016/j.physio.2019.08.005

Sherrington, C., Lord, S. R., Vogler, C. M., Close, J. C., Howard, K., Dean, C. M., Heller, G. Z., Clemson, L., O'Rourke, S. D., Ramsay, E., Barraclough, E., Herbert, R. D., & Cumming, R. G. (2014). A post-hospital home exercise program improved mobility but increased falls in older people: a randomised controlled trial. *PloS one*, *9*(9), e104412. https://doi.org/10.1371/journal.pone.0104412

Deer, R. R., Dickinson, J. M., Baillargeon, J., Fisher, S. R., Raji, M., & Volpi, E. (2019). A Phase I Randomized Clinical Trial of Evidence-Based, Pragmatic Interventions to Improve Functional Recovery After Hospitalization in Geriatric Patients. *The journals of gerontology. Series A, Biological sciences and medical sciences*, *74*(10), 1628–1636. https://doi.org/10.1093/gerona/glz084

Clegg, A. P., Barber, S. E., Young, J. B., Forster, A., & Iliffe, S. J. (2012). Do home-based exercise interventions improve outcomes for frail older people? Findings from a systematic review. *Reviews in clinical gerontology*, *22*(1), 68–78. https://doi.org/10.1017/S0959259811000165

Tsekoura, M., Billis, E., Tsepis, E., Dimitriadis, Z., Matzaroglou, C., Tyllianakis, M., Panagiotopoulos, E., & Gliatis, J. (2018). The Effects of Group and Home-Based Exercise Programs in Elderly with Sarcopenia: A Randomized Controlled Trial. *Journal of clinical medicine*, *7*(12), 480. https://doi.org/10.3390/jcm7120480

Wang, R., Liang, Y., Jiang, J., Chen, M., Li, L., Yang, H., Tan, L., & Yang, M. (2020). Effectiveness of a Short-Term Mixed Exercise Program for Treating Sarcopenia in Hospitalized Patients Aged 80 Years and Older: A Prospective Clinical Trial. *The journal of nutrition, health & aging*, *24*(10), 1087–1093. https://doi.org/10.1007/s12603-020-1429-x

Kosse, N. M., Dutmer, A. L., Dasenbrock, L., Bauer, J. M., & Lamoth, C. J. (2013). Effectiveness and feasibility of early physical rehabilitation programs for geriatric hospitalized patients: a systematic review. *BMC geriatrics*, *13*, 107. https://doi.org/10.1186/1471-2318-13-107

Kanach, F. A., Pastva, A. M., Hall, K. S., Pavon, J. M., & Morey, M. C. (2018). Effects of Structured Exercise Interventions for Older Adults Hospitalized With Acute Medical Illness: A Systematic Review. *Journal of aging and physical activity*, *26*(2), 284–303. https://doi.org/10.1123/japa.2016-0372

Lacroix, A., Hortobágyi, T., Beurskens, R., & Granacher, U. (2017). Effects of Supervised vs. Unsupervised Training Programs on Balance and Muscle Strength in Older Adults: A Systematic Review and Meta-Analysis. *Sports medicine (Auckland, N.Z.)*, *47*(11), 2341–2361. https://doi.org/10.1007/s40279-017-0747-6

Aranha, A., Smitherman, H. C., Jr, Patel, D., & Patel, P. J. (2020). Association of Hospital Readmissions and Survivability With Frailty and Palliative Performance Scores Among Long-Term Care Residents. *The American journal of hospice & palliative care*, *37*(9), 716–720. https://doi.org/10.1177/1049909120907602

O'Brien, S., Kavanagh, R. G., Carey, B. W., Maher, M. M., O'Connor, O. J., & Andrews, E. J. (2018). The impact of sarcopenia and myosteatosis on postoperative outcomes in patients with inflammatory bowel disease. *European radiology experimental*, *2*(1), 37. https://doi.org/10.1186/s41747-018-0072-3

Yilmaz, O., Aykent, B., & Bahat, G. (2019). Small, however significant differences in the definition of physical frailty, and sarcopenia. *European journal of internal medicine*, *61*, e9. https://doi.org/10.1016/j.ejim.2018.11.005

Guglielmi, G., Ponti, F., Agostini, M., Amadori, M., Battista, G., & Bazzocchi, A. (2016). The role of DXA in sarcopenia. *Aging clinical and experimental research*, *28*(6), 1047–1060. https://doi.org/10.1007/s40520-016-0589-3

Thompson, M. Q., Yu, S., Tucker, G. R., Adams, R. J., Cesari, M., Theou, O., & Visvanathan, R. (2021). Frailty and sarcopenia in combination are more predictive of mortality than either condition alone. *Maturitas*, *144*, 102–107. https://doi.org/10.1016/j.maturitas.2020.11.009

Han, C. Y., Miller, M., Yaxley, A., Baldwin, C., Woodman, R., & Sharma, Y. (2020). Effectiveness of combined exercise and nutrition interventions in prefrail or frail older hospitalised patients: a systematic review and meta-analysis. *BMJ open*, *10*(12), e040146. https://doi.org/10.1136/bmjopen-2020-040146

Beckwée, D., Delaere, A., Aelbrecht, S., Baert, V., Beaudart, C., Bruyere, O., de Saint-Hubert, M., & Bautmans, I. (2019). Exercise Interventions for the Prevention and Treatment of Sarcopenia. A Systematic Umbrella Review. *The journal of nutrition, health & aging*, *23*(6), 494–502. https://doi.org/10.1007/s12603-019-1196-8

Martínez-Velilla, N., Casas-Herrero, A., Zambom-Ferraresi, F., Sáez de Asteasu, M. L., Lucia, A., Galbete, A., García-Baztán, A., Alonso-Renedo, J., González-Glaría, B., Gonzalo-Lázaro, M., Apezteguía Iráizoz, I., Gutiérrez-Valencia, M., Rodríguez-Mañas, L., & Izquierdo, M. (2019). Effect of Exercise Intervention on Functional Decline in Very Elderly Patients During Acute Hospitalization: A Randomized Clinical Trial. *JAMA internal medicine*, *179*(1), 28–36. https://doi.org/10.1001/jamainternmed.2018.4869

Liang, Y., Wang, R., Jiang, J., Tan, L., & Yang, M. (2020). A randomized controlled trial of resistance and balance exercise for sarcopenic patients aged 80-99 years. *Scientific reports*, *10*(1), 18756. https://doi.org/10.1038/s41598-020-75872-2

Bulthuis, Y., Drossaers-Bakker, K. W., Taal, E., Rasker, J., Oostveen, J., van't Pad Bosch, P., Oosterveld, F., & van de Laar, M. (2007). Arthritis patients show long-term benefits from 3 weeks intensive exercise training directly following hospital discharge. *Rheumatology (Oxford, England)*, *46*(11), 1712–1717. https://doi.org/10.1093/rheumatology/kem236

Benzo, R., Wetzstein, M., Neuenfeldt, P., & McEvoy, C. (2015). Implementation of physical activity programs after COPD hospitalizations: Lessons from a randomized study. *Chronic respiratory disease*, *12*(1), 5–10. https://doi.org/10.1177/1479972314562208

Mudge, A. M., Denaro, C. P., Scott, A. C., Meyers, D., Adsett, J. A., Mullins, R. W., Suna, J. M., Atherton, J. J., Marwick, T. H., Scuffham, P., & O'Rourke, P. (2018). Addition of Supervised Exercise Training to a Post-Hospital Disease Management Program for Patients Recently Hospitalized With Acute Heart Failure: The EJECTION-HF Randomized Phase 4 Trial. *JACC. Heart failure*, *6*(2), 143–152. https://doi.org/10.1016/j.jchf.2017.11.016

Anker, S. D., & Coats, A. (2021). Exercise for Frail, Elderly Patients with Acute Heart Failure - A Strong Step Forward. *The New England journal of medicine*, 10.1056/NEJMe2106140. Advance online publication. https://doi.org/10.1056/NEJMe2106140

Sanchis, J., Sastre, C., Ruescas, A., Ruiz, V., Valero, E., Bonanad, C., García-Blas, S., Fernández-Cisnal, A., González, J., Miñana, G., & Núñez, J. (2021). Randomized Comparison of Exercise Intervention Versus Usual Care in Older Adult Patients with Frailty After Acute Myocardial Infarction. *The American journal of medicine*, *134*(3), 383–390.e2. https://doi.org/10.1016/j.amjmed.2020.09.019

Folstein, M. F., Folstein, S. E., & McHugh, P. R. (1975). "Mini-mental state". A practical method for grading the cognitive state of patients for the clinician. *Journal of psychiatric research*, *12*(3), 189–198. https://doi.org/10.1016/0022-3956(75)90026-6

Echeverria, I., Amasene, M., Urquiza, M., Labayen, I., Anaut, P., Rodriguez-Larrad, A., Irazusta, J., & Besga, A. (2020). Multicomponent Physical Exercise in Older Adults after Hospitalization: A Randomized Controlled Trial Comparing Short- vs. Long-Term Group-Based Interventions. *International journal of environmental research and public health*, *17*(2), 666. https://doi.org/10.3390/ijerph17020666

Urquiza, M., Echeverria, I., Besga, A., Amasene, M., Labayen, I., Rodriguez-Larrad, A., Barroso, J., Aldamiz, M., & Irazusta, J. (2020). Determinants of participation in a post-hospitalization physical exercise program for older adults. *BMC geriatrics*, *20*(1), 408. https://doi.org/10.1186/s12877-020-01821-3

Cruz-Jentoft, A. J., Bahat, G., Bauer, J., Boirie, Y., Bruyère, O., Cederholm, T., Cooper, C., Landi, F., Rolland, Y., Sayer, A. A., Schneider, S. M., Sieber, C. C., Topinkova, E., Vandewoude, M.,

Visser, M., Zamboni, M., & Writing Group for the European Working Group on Sarcopenia in Older People 2 (EWGSOP2), and the Extended Group for EWGSOP2 (2019). Sarcopenia: revised European consensus on definition and diagnosis. *Age and ageing*, *48*(1), 16–31. https://doi.org/10.1093/ageing/afy169

Bakeman R. (2005). Recommended effect size statistics for repeated measures designs. *Behavior research methods*, *37*(3), 379–384. https://doi.org/10.3758/bf03192707

Hopkins, W. G., Marshall, S. W., Batterham, A. M., & Hanin, J. (2009). Progressive statistics for studies in sports medicine and exercise science. *Medicine and science in sports and exercise*, *41*(1), 3–13. https://doi.org/10.1249/MSS.0b013e31818cb278

De Biasio, J. C., Mittel, A. M., Mueller, A. L., Ferrante, L. E., Kim, D. H., & Shaefi, S. (2020). Frailty in Critical Care Medicine: A Review. *Anesthesia and analgesia*, *130*(6), 1462–1473. https://doi.org/10.1213/ANE.0000000000004665

Gill, T. M., Gahbauer, E. A., Han, L., & Allore, H. G. (2011). The relationship between intervening hospitalizations and transitions between frailty states. *The journals of gerontology. Series A, Biological sciences and medical sciences*, *66*(11), 1238–1243. https://doi.org/10.1093/gerona/glr142

Merchant, R. A., Morley, J. E., & Izquierdo, M. (2021). Editorial: Exercise, Aging and Frailty: Guidelines for Increasing Function. *The journal of nutrition, health & aging*, *25*(4), 405–409. https://doi.org/10.1007/s12603-021-1590-x

Chen, C. C., Wang, C., & Huang, G. H. (2008). Functional trajectory 6 months posthospitalization: a cohort study of older hospitalized patients in Taiwan. *Nursing research*, *57*(2), 93–100. https://doi.org/10.1097/01.NNR.0000313485.18670.e2

Aarden, J. J., Reijnierse, E. M., van der Schaaf, M., van der Esch, M., Reichardt, L. A., van Seben, R., Bosch, J. A., Twisk, J., Maier, A. B., Engelbert, R., Buurman, B. M., & Hospital-ADL study group (2021). Longitudinal Changes in Muscle Mass, Muscle Strength, and Physical Performance in Acutely Hospitalized Older Adults. *Journal of the American Medical Directors Association*, *22*(4), 839–845.e1. https://doi.org/10.1016/j.jamda.2020.12.006

Gill, T. M., Allore, H. G., Gahbauer, E. A., & Murphy, T. E. (2010). Change in disability after hospitalization or restricted activity in older persons. *JAMA*, *304*(17), 1919–1928. https://doi.org/10.1001/jama.2010.1568

Talar, K., Hernández-Belmonte, A., Vetrovsky, T., Steffl, M., Kałamacka, E., & Courel-Ibáñez, J. (2021). Benefits of Resistance Training in Early and Late Stages of Frailty and Sarcopenia: A Systematic Review and Meta-Analysis of Randomized Controlled Studies. *Journal of clinical medicine*, *10*(8), 1630. https://doi.org/10.3390/jcm10081630

Lozano-Montoya, I., Correa-Pérez, A., Abraha, I., Soiza, R. L., Cherubini, A., O'Mahony, D., & Cruz-Jentoft, A. J. (2017). Nonpharmacological interventions to treat physical frailty and sarcopenia in older patients: a systematic overview - the SENATOR Project ONTOP Series. *Clinical interventions in aging*, *12*, 721–740. https://doi.org/10.2147/CIA.S132496

Ligthart-Melis, G. C., Luiking, Y. C., Kakourou, A., Cederholm, T., Maier, A. B., & de van der Schueren, M. (2020). Frailty, Sarcopenia, and Malnutrition Frequently (Co-)occur in Hospitalized Older Adults: A Systematic Review and Meta-analysis. *Journal of the American Medical Directors Association*, *21*(9), 1216–1228. https://doi.org/10.1016/j.jamda.2020.03.006

Ruiz, J. G., Dent, E., Morley, J. E., Merchant, R. A., Beilby, J., Beard, J., Tripathy, C., Sorin, M., Andrieu, S., Aprahamian, I., Arai, H., Aubertin-Leheudre, M., Bauer, J. M., Cesari, M., Chen, L. K., Cruz-Jentoft, A. J., De Souto Barreto, P., Dong, B., Ferrucci, L., Fielding, R., … Vellas, B. (2020). Screening for and Managing the Person with Frailty in Primary Care: ICFSR Consensus Guidelines. *The journal of nutrition, health & aging*, *24*(9), 920–927. https://doi.org/10.1007/s12603-020-1492-3

Bouillon, K., Kivimaki, M., Hamer, M., Sabia, S., Fransson, E. I., Singh-Manoux, A., Gale, C. R., & Batty, G. D. (2013). Measures of frailty in population-based studies: an overview. *BMC geriatrics*, *13*, 64. https://doi.org/10.1186/1471-2318-13-64

Bertschi, D., Kiss, C. M., Beerli, N., & Kressig, R. W. (2021). Sarcopenia in hospitalized geriatric patients: insights into prevalence and associated parameters using new EWGSOP2 guidelines. *European journal of clinical nutrition*, *75*(4), 653–660. https://doi.org/10.1038/s41430-020-00780-7

Ibrahim, K., Howson, F., Culliford, D. J., Sayer, A. A., & Roberts, H. C. (2019). The feasibility of assessing frailty and sarcopenia in hospitalised older people: a comparison of commonly used tools. *BMC geriatrics*, *19*(1), 42. https://doi.org/10.1186/s12877-019-1053-y

Lacroix, A., Kressig, R. W., Muehlbauer, T., Gschwind, Y. J., Pfenninger, B., Bruegger, O., & Granacher, U. (2016). Effects of a Supervised versus an Unsupervised Combined Balance and Strength Training Program on Balance and Muscle Power in Healthy Older Adults: A Randomized Controlled Trial. *Gerontology*, *62*(3), 275–288. https://doi.org/10.1159/000442087

Escriche-Escuder, A., Fuentes-Abolafio, I. J., Roldán-Jiménez, C., & Cuesta-Vargas, A. I. (2021). Effects of exercise on muscle mass, strength, and physical performance in older adults with sarcopenia: A systematic review and meta-analysis according to the EWGSOP criteria. *Experimental gerontology*, 111420. Advance online publication. https://doi.org/10.1016/j.exger.2021.111420

Tieland, M., van de Rest, O., Dirks, M. L., van der Zwaluw, N., Mensink, M., van Loon, L. J., & de Groot, L. C. (2012). Protein supplementation improves physical performance in frail elderly people: a randomized, double-blind, placebo-controlled trial. *Journal of the American Medical Directors Association*, *13*(8), 720–726. https://doi.org/10.1016/j.jamda.2012.07.005

Bourdel-Marchasson, I., Joseph, P. A., Dehail, P., Biran, M., Faux, P., Rainfray, M., Emeriau, J. P., Canioni, P., & Thiaudière, E. (2001). Functional and metabolic early changes in calf muscle occurring during nutritional repletion in malnourished elderly patients. *The American journal of clinical nutrition*, *73*(4), 832–838. https://doi.org/10.1093/ajcn/73.4.832

Leenders, M., Verdijk, L. B., van der Hoeven, L., van Kranenburg, J., Nilwik, R., & van Loon, L. J. (2013).Elderly men and women benefit equally from prolonged resistance-type exercise training. *The journals of gerontology. Series A, Biological sciences and medical sciences*, *68*(7), 769–779. https://doi.org/10.1093/gerona/gls241

Makizako, H., Nakai, Y., Tomioka, K., Taniguchi, Y., Sato, N., Wada, A., Kiyama, R., Tsutsumimoto, K., Ohishi, M., Kiuchi, Y., Kubozono, T., & Takenaka, T. (2020). Effects of a Multicomponent Exercise Program in Physical Function and Muscle Mass in Sarcopenic/Pre-Sarcopenic Adults. *Journal of clinical medicine*, 9(5), 1386. https://doi.org/10.3390/jcm905138

4.4. Article 4:

Identification of frailty and sarcopenia in hospitalised older people.

Iñaki Echeverria, Ariadna Besga, Begoña Sanz, María Amasene, Gotzone Hervás, Julia Barroso, Ana Rodriguez-Larrad and Jon Irazusta.

Received: 29 April 2020; Revised: 28 August 2020; Accepted: 28 September 2020; Published Online: 01 December 2020; Published: April 2021

Eur. J. Clin. Invest. **2020**, 00:e13420; doi:10.1111/eci.13420

Abstract

Background: People with frailty and/or sarcopenia have an increased risk of negative health outcomes. However, their diagnosis is often difficult. Considering the potential value of myostatin and follistatin as biomarkers of these conditions, we aimed to compare the association between both myokines and frailty and/or sarcopenia in post-hospitalised older people. In addition, the capability of myostatin and follistatin for identifying frailty and sarcopenia was compared with physical tests.

Materials and methods: Participants in this cross-sectional study consisted of 84 post-hospitalised patients immediately after discharge. Participants met the following inclusion criteria: aged ≥ 70 years, score of ≥20 on the Mini-Mental State Examination, and able to stand up and walk independently for at least 4 m. Serum myostatin and follistatin concentrations were measured by enzyme-linked immunosorbent assay. Body measures and results from 4 physical tests (hand grip, chair stand, 8-foot timed Up and Go (8TUG) and gait speed (GS)) were also recorded. Frailty was evaluated by the Fried index, and sarcopenia by the criteria of the European Working Group on Sarcopenia in Older People.

Results: Myostatin concentration was lower and follistatin concentration higher in people with frailty or sarcopenia. Receiver operating characteristic curves indicated that GS and 8TUG tests had the greatest capability for identifying frailty. Myostatin was the only variable capable of identifying sarcopenia.

Conclusion: Myostatin may be a useful biomarker for sarcopenia in post-hospitalised older adults. However, it has a lower capability for identifying frailty than physical tests. Further studies using larger samples and these myokines together with other biomarkers are warranted.

KEYWORDS

DXA, follistatin, muscle, myostatin, physical function

1 | INTRODUCTION

As the population ages, recent years have seen increased interest in frailty and sarcopenia in health policy and research. Frailty is considered an age-related syndrome which leaves older adults more vulnerable when facing minor stressors and, consequently, exposes them to a higher risk of adverse health-related events such as falls, hospitalisation and even death.[1] Meanwhile, sarcopenia is a progressive and generalized skeletal muscle disorder involving accelerated loss of muscle mass and function.[2] As in frailty, sarcopenia increases the risk of adverse events such as disability, loss of independence and premature death.[3] Even though both conditions share several characteristics in common, there are small, but significant, differences between them.[4] The main difference is that low muscle mass is a central factor for identifying sarcopenia but not frailty, which is also defined by behavioural and mood-related variables.[5]

Hospitalisation can be related to both frailty and sarcopenia. Frailty syndrome is highly prevalent among hospitalized older adults,[6] and sarcopenia might appear acutely during hospital admission, especially in older adults.[2] Since frailty[7] and sarcopenia[8] are also associated with an increased risk of hospital readmission, the link between hospitalisation and frailty/sarcopenia might result in a vicious circle that could lead to a sharp functional decline.

Both frailty and sarcopenia are considered reversible conditions,[9] and therefore, their early detection is of the utmost importance. However, it is not always feasible to perform an accurate assessment in clinical settings. Frailty indexes usually include some physical tests and questionnaires which are time consuming, and sarcopenia diagnosis requires expensive tests such as dual-energy X-ray absorptiometry (DXA).[10] Single tests of physical fitness, including those used to measure strength,[11,12] gait speed,[12] or agility and dynamic balance[13] have been proposed as alternative tools to identify frailty or sarcopenia. However, those tests may be difficult in hospital settings where special conditions must be considered, such as highly vulnerable inpatients and time and/or space limitations.

Molecular biomarkers can be easily measured andevaluated as indicators of physiological and pathogenic processes. Impaired physical function may represent the shared core of physical frailty and sarcopenia.[14] Therefore, molecular biomarkers linked to muscular structure and function are good candidates for frailty and/or sarcopenia biomarkers.

Myostatin is highly expressed in the skeletal muscle, enhances proteolysis and inhibits protein synthesis, and is a robust negative regulator of muscle mass.[15] However, studies reporting the association of myostatin with frailty- and sarcopenia-related variables have shown contradictory results. Some have found the expected negative association between myostatin and muscular mass[16] or physical function,[17] whereas

others have reported the opposite[18]: higher myostatin concentration related to greater muscle mass and better muscle function. Our recent study found a negative association between frailty and myostatin in older adults living in nursing homes.[19]

Follistatin is a myostatin-binding protein that inhibits myostatin activity and promotes muscle growth.[20] However, as with myostatin, studying the association of follistatin with muscle and physical function,[21] ageing, frailty and sarcopenia[22,23] has produced controversial results.

Considering the potential value of myostatin and follistatin as molecular biomarkers of frailty and sarcopenia, the objective of this study was to analyse the differences in myostatin and follistatin serum concentration in post-hospitalised older adults with and without frailty and sarcopenia. In addition, we compared the capability of both proteins to identify frailty and/or sarcopenia with the ability of validated simple physical tests to find easy and economical alternatives to the current diagnosis of mentioned conditions.

2 | METHODS

2.1 | Trial design and participants

This cross-sectional study is a secondary analysis of baseline data from two randomised studies conducted at the University Hospital of Araba, Spain (ACTRN12619000093189, ClinicalTrials.gov ID:NCT03815201) between November 2017 and July 2018. The primary results of these trials were recently published.[24,25] Reporting of the study conforms to broad EQUATOR guidelines (Simera et al January 2010 issue of EJCI).[26]

We recruited 84 post-hospitalised patients from the Internal Medicine and Neurology Departments. Participants met the following inclusion criteria: aged ≥ 70 years, score of ≥20 on the Mini-Mental State Examination (MMSE),[27] and able to stand up and walk independently for at least 4 m at a time. Patients were excluded if they met any of the following exclusion criteria: chronic kidney disease, severe dementia, autoimmune neuromuscular disease, acute myocardial infarction or bone fracture in the past 3 months. Blood extraction, physical tests and DXA were performed 7-15 days after discharge. Participants had not undergone any physical rehabilitation before the assessment.

All participants were informed of the extent of the study and signed an informed consent document approved by the Committee on Ethics in Clinical Research at the University Hospital of Araba (CEIC-HUA 2017-021). The Biological Agents Committee of the University of the Basque Country (CEIAB M30/2018/201) also approved the study.

2.2 | Sociodemographic, clinical and nutritional data

Patients' demographic data (sex and age) and comorbidity, assessed through the Charlson Comorbidity Index (CCI),[28] and polypharmacy were retrieved from the database of the Basque Public Health Service. Nutritional status of the participants was

assessed by the Mini Nutritional Assessment (MNA).[29]

2.3 | Serum myostatin and follistatin concentration

Blood samples were collected in the morning, following an overnight fast. Following collection, the tubes were centrifuged at 5000 g for 10 minutes. The serum obtained from each participant was stored at −80°C for further analysis. A commercial enzyme-linked immunosorbent assay (ELISA) was performed to measure both biomarkers' serum concentrations. Total myostatin and follistatin (ng/mL) were measured according to the manufacturer's protocol (GDF-8/Myostatin and Follistatin Quantikine ELISA Kits R&D Systems Inc). In both cases, the quantification was performed spectrophotometrically by FLUOstar OPTIMA Microplate reader (Thermo Fisher Scientific) and Optima Control software version 2.20 (BMG, LabTech). Analyses were measured in duplicate and averaged.

2.4 | **Anthropometry and body composition**

Anthropometric measurements were taken by the same researcher certified in anthropometric testing (ISAK I), following the recommended protocol by the International Society for the Advancement of Kinanthropometry (ISAK). Body mass was measured with an OmronHN288 digital scale to the nearest 0.1 kg. Height was estimated as reported by Chumlea et al.[30] Body mass index was also calculated. Appendicular skeletal muscle mass (ASM) was assessed by DXA (HOLOGIC, QDR 4500).

2.5 | Physical function

Several tests were used to evaluate the physical function of the participants: hand grip strength was assessed using a Jamar dynamometer,[31] lower limb muscle strength and agility or dynamic balance were assessed by Chair Stand Test (CST) and 8-Foot Timed Up and Go Test (8TUG) of the Senior Fitness Test,[32] respectively. Gait speed (GS) over 8 metres[33] was also assessed.

2.6 | Frailty status

Frailty status was assessed using the Fried index. This index evaluates the presence of 5 criteria: slow walking speed, reduced grip strength, low physical activity, exhaustion and unintentional weight loss. Individuals are considered frail when they meet 3 criteria out of the 5.[1]

2.7 | Sarcopenia

The cut-off points proposed by the European Working Group on Sarcopenia in Older People (EWGSOP2) were used for the assessment of sarcopenia.[34] Thus, participants with low grip strength (<27 kg for men and <16 kg for women), or those who needed more than 15 seconds to comlete 5 rises in the CST, were classified as candidates for sarcopenia. Sarcopenia was confirmed when the ASM was lower than 7.0 kg/m^2 for men

and 5.5 kg/m^2 for women.

2.8 | Statistical analysis

Statistical analysis was performed using the IBM SPSS Statistics 24 software package (SPSS, Inc). Normal distribution of the data was verified using the Kolmogorov- Smirnov test. Descriptive data were analysed by the calculation of the mean and standard deviation for normal continuous variables, and by calculating the median and interquartile range for the non-normal variables. Categorical variables were expressed as frequency counts and percentages (%). The difference in concentrations of molecular biomarkers between individuals with and without frailty or sarcopenia was compared by the Mann-Whitney U. Medians and interquartile ranges were calculated for each case. Logistic binary regressions were performed to assess which physical or biomolecular variables were significantly associated with frailty or sarcopenia. A new variable was created with the coefficients obtained, introducing myostatin and follistatin into the same equation. Age, sex and CCI were introduced as covariables into all the equations. Receiver operating characteristic (ROC) curves were also constructed for calculating the area under the curve (AUC), with those variables significantly associated with each of the conditions in the logistic regressions. The cut-off points were calculated by the Youden Index,[35] and the specificity and sensibility of each curve for identifying frailty and sarcopenia were determined. AUC values of >0.7, >0.8 and 0.9 were considered acceptable, excellent and outstanding, respectively. In all the analyses, missed values were pairwise deleted. The significance level for all tests was set at P <.05.

3 | RESULTS

3.1 | Characteristics of study participants

The characteristics of the participants are listed in Table 1. Of the 84 participants, 38 were men and 46 were women. The median age of the participants was 83 years (interquartile range: 78-87.8). 47 out of 84 participants were frail, 15 out of 74 met the sarcopenia criteria, and 11 out of 74 had both conditions. 10 of the participants were not assessed for sarcopenia.

3.2 | Serum myostatin and follistatin concentrations according to frailty and sarcopenia

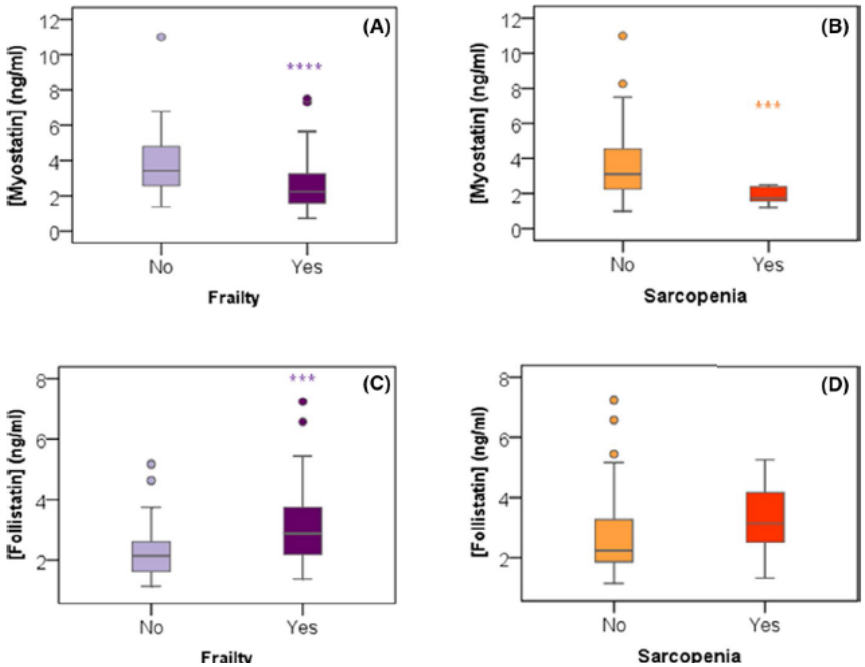
In Figure 1, medians and interquartile ranges are represented for each biomarker and condition (frailty or sarcopenia). Myostatin concentration was lower in frail than in non-frail individuals (P < .001). Patients with sarcopenia also showed lower levels of myostatin than those without sarcopenia (P < .001). However, although follistatin was higher in patients with frailty (P = .004) no significant differences were found between patients with or without sarcopenia.

TABLE 1 Descriptive characteristics of the study participants.

Variable	Value	
	n (%)	Median (IQR) Mean ± SD
Sex		
Men	38 (45.2)	
Women	46 (54.8)	
Age (y)	84	83(78-87.8)
Charlson Comorbidity Index	84	5 (4-6)
Mini Nutritional Assessment (score: 0-30)	78	12.5 (11.4-13.5)
Normal (score > 24)	33 (42.3)	
Risk (17 < score <23.5)	41 (52.3)	
Malnutrition (score ≤ 17)	4 (5.1)	
Polypharmacy	84	6 (4.3-9)
Oligopharmacy (<5)	21 (25)	
Polypharmacy (5-9)	43 (51.2)	
Severe polypharmacy (≥10)	20 (23.8)	
Myostatin (ng/mL)	84	2.6 (1.9-4.3)
Follistatin (ng/mL)	84	2.3 (1.9-3.3)
Anthropometry and body composition		
Body mass (kg)	78	71.3 ± 14.9
Height (cm)	80	155.6 (151.7-163.9)
Body mass index (kg/m2)	78	28.7 ± 5.7
Physical fitness		
Hand Grip (kg)	84	24.1 ±7.5
Chair Stand (reps in 30 s)	84	14 (11-16.5)
8-Foot Timed Up and Go Test (m/s)	84	0.2 ± 0.08
Gait Speed (m/s)	84	0.9 ± 0.3
Frailty	84	
No	37 (44.05)	
Yes	47 (55.95)	
Sarcopenia	74	
No	59 (79.7)	
Yes	15 (20.3)	

Abbreviations: IQR, interquartile range; SD, standard deviation.

FIGURE 1 Medians and interquartile ranges of serum myostatin concentration (ng/ml) in patients with and without frailty (A) or sarcopenia (B). Medians and interquartile ranges of serum follistatin concentration (ng/mL) in patients with and without frailty (C) or sarcopenia (D). ****P < .001, ***P < .005. Frailty: n = 84; Sarcopenia n = 75



3.3 | Logistic regression models

Seven logistic regression models were constructed for frailty (Table 2) and seven for sarcopenia as outcome variables (Table 3). To identify each condition (frailty and sarcopenia), one of these 7 variables was introduced into the model: hand grip, CST, 8TUG, GS, myostatin and follistatin independently, and myostatin and follistatin together. Considering the differences in the normative values of hand grip strength for defining frailty and sarcopenia between men and women, absolute values obtained in this test were normalised according to the cut-off point of each condition. Significant negative associations were found when the performance in physical tests and the concentration of myostatin were introduced as independent variables for identifying frailty: hand grip (β = −0.12, P=.002), CST (β = −0.21, P = .001), 8TUG (β = −16.2, P<.001), GS (β = −5.9, P<.001) and myostatin (β = −0.34, P = .016). In contrast, the association of follistatin concentration and frail status was positive (β = 0.64, P=.008). When myostatin was introduced into the regression together with follistatin, the capability for identifying frailty of the equation increased (Nagelkerke's R2 = 0.28) compared to that obtained for both biomarkers separately (Nagelkerke's R2 = 0.17 for myostatin and 0.21 for follistatin). When sarcopenia was the outcome variable, only the concentration of myostatin was significantly linked to it in a negative way (β = −0.70, P=.021).

TABLE 2 Backward logistic regression models for frailty as outcome variable and functional tests and molecular biomarkers as independent variables

Independent variable(s)	β	P	Odds ratio (95% CI)	Nagelkerke's R^2
Hand grip (%)[a]	-0.04	.001	0.96 (0.94–0.99)	0.20
Chair Stand Test (reps in 30 s)	-0.21	.001	0.81 (0.72–0.92)	0.22
8 Timed Up and Go Test (m/s)	-16.2	<.001	9·10-8 (3.4·10-11–2·10-4)	0.33
Gait speed (m/s)	-5.9	<.001	0.003 (2.10-4–0.04)	0.40
Myostatin (ng/mL)	-0.34	.016	0.71 (0.54–0.94)	0.17
Follistatin (ng/mL)	0.64	.008	1.90 (1.19–3.05)	0.21
Myostatin (ng/mL)	-0.29	.036	0.75 (0.58–0.98)	0.28
Follistatin (ng/mL)	0.58	.016	1.79 (1.11–2.87)	

Note: N = 84; CI, confidence interval. Sex, age and Charlson Comorbidity Index were introduced as covariables in the regression.
[a]Introduced in the model as the percentage of hand grip strength related to the cut-off points depending on sex: <20 kg for women and <30 kg for men.

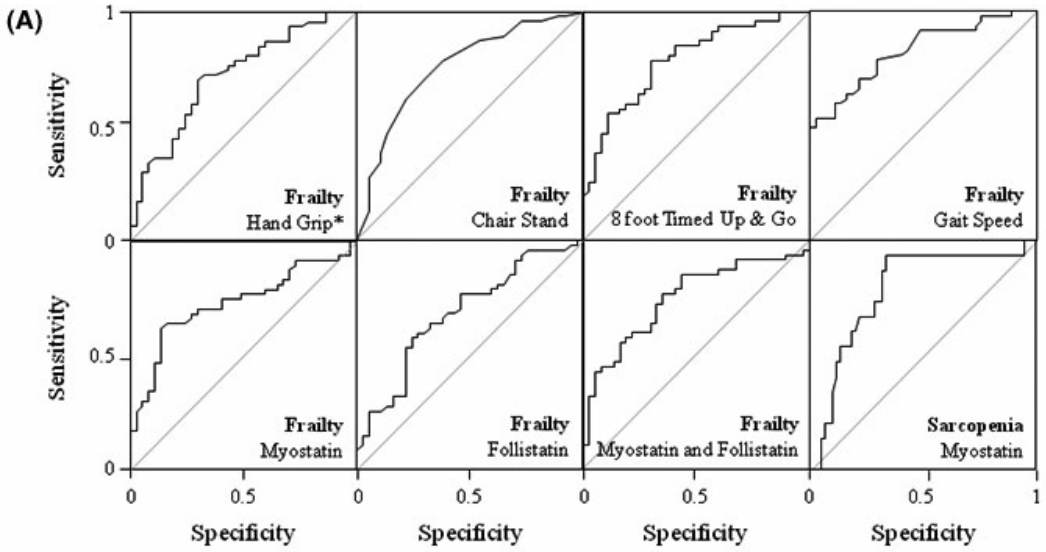
TABLE 3 Backward logistic regression models for sarcopenia as dependent variable and functional tests and molecular biomarkers as independent variables

Independent variable(s)	β	P	Odds ratio (95% CI)	Nagelkerke's R2
Hand grip (%)[a]	-0.02	.089	0.98 (0.96–1.00)	0.06
Chair Stand Test (reps in 30 s)	-0.01	.911	0.96 (0.88–1.04)	0.02
8 Timed Up and Go Test (m/s)	-3,1	.378	0.05 (5·10-5–43.4)	0.02
Gait speed (m/s)	-0.94	.381	0.38 (0.05–3.18)	0.02
Myostatin (ng/mL)	-0.70	.021	0.50 (0.27–0.90)	0.17
Follistatin (ng/mL)	0.29	.169	1.34 (0.88–2.02)	0.04
Myostatin (ng/mL)	-0.65	.032	0.52 (0.29–0.95)	0.18
Follistatin (ng/mL)	0.19	.425	1.22 (0.76–1.91)	

Note: N = 75; CI, confidence interval. Sex, age and Charlson Comorbidity Index were introduced as covariables in the regression.
[a]Introduced in the model as the percentage of hand grip strength related to the cut-off points depending on sex: <27 kg for men, <16 kg for women.

FIGURE 2 (A) ROC curves and (B) corresponding variables for frailty (n = 84) and sarcopenia (n = 75) as state variable. Hand grip, Chair Stand and 8-Foot Timed Up and Go Tests, gait speed, myostatin, follistatin, and myostatin and follistatin together as test variables for frailty. Myostatin as test variable for sarcopenia. AUC, area under the curve; CI, confidence interval; SEN, sensitivity; SPE, specificity. *Percentage of hand grip strength related to cut-off point depending on sex (20 kg for women and 30 kg for men)

(A)



(B)

State variable	Test	AUC	95% CI	p	SEN	SPE	Cutoff
Frailty n = 84	Hand grip (%)*	0.72	(0.61-0.86)	.001	0.70	0.70	99.5 %
	Chair Stand (reps in 30 s)	0.76	(0.65-0.86)	<.001	0.79	0.62	≤11 stands
	8-Foot Timed Up and Go (m/s)	0.79	(0.68-0,88)	<.001	0.70	0.79	<0.24 m/s
	Gait speed (m/s)	0.82	(0.74-0.91)	<.001	0.64	0.89	<0.87 m/s
	Myostatin (ng/mL)	0.73	(0.62-0.84)	<.001	0.62	0.87	<2.29 ng/mL
	Follistatin (ng/mL)	0.68	(0.57-0.80)	.004	0.57	0.66	>2.63 ng/mL
	Myostatin (ng/mL) Follistatin (ng/mL)	0.75	(0.64-0.85)	<.001	0.85	0.57	>0.15
Sarcopenia n = 75	Myostatin (ng/mL)	0.78	(0.65-0.91)	.001	0.93	0.66	<2.5 ng/mL

3.4 | ROC curves

ROC curves were plotted to illustrate the ability to identify frailty or sarcopenia of the variables that were significant in the previous regression models. The curves and the calculated variables (AUC, sensitivity, specificity and cut-off points) are shown in Figure 2. Regarding frailty, an AUC of 0.82 was found for GS (with a sensitivity of 0.64 and a specificity of 0.89). AUCs between 0.7 and 0.8 were observed for 8TUG (0.79), CST (0.76), hand grip (0.72), myostatin (0.73) and myostatin with follistatin (0.75). The

lowest AUC was calculated for the concentration of follistatin (0.68). The highest sensitivity of the tests for identifying frailty was found for the combination of myostatin and follistatin (0.85), followed by CST (0.79), 8TUG (0.70), hand grip (0.70), GS (0.64), myostatin (0.62) and follistatin (0.57). GS showed the highest specificity (0.89), with lower values for myostatin (0.87), 8TUG (0.79), hand grip (0.70), follistatin (0.66), CST (0.62), and the combination of myostatin and follistatin (0.57).

When sarcopenia was assessed as the state variable, the AUC for myostatin was 0.78, with a sensitivity of 0.93 and a specificity of 0.66.

4 | DISCUSSION

In this study, we found that whereas myostatin concentration was lower in people with frailty or sarcopenia, follistatin was higher in people with frailty. Regression equations and ROC curves indicated that GS and 8TUG tests had greater capability for identifying frailty than molecular biomarkers. Myostatin was the only assessed variable capable of identifying sarcopenia significantly.

Myostatin and follistatin have opposite functions: whereas myostatin enhances proteolysis and inhibits protein synthesis in skeletal muscle,[15] follistatin promotes muscle growth.[20] However, our results are not in accordance with the function of each protein. Indeed, we observed a negative association between myostatin and frailty and sarcopenia and follistatin was positively associated with frailty. This accords with some previous studies,[18,19,21] but not with others reporting higher myostatin concentration[15] in people with worse physical function and higher follistatin and lower myostatin after resistance training.[36]

Low myostatin and high follistatin circulating levels were also identified in patients with muscle-wasting diseases, suggesting that both proteins could participate in an internal mechanism aimed at reducing further muscle loss.[37] In this regard, some authors have proposed that myostatin could act as a chalone, restraining skeletal muscle growth in response to unfavourable metabolic scenarios and decreasing its activity when there is no need for growth inhibition.[17]

In the regression models, the performance in physical tests, and the serum concentration of myostatin and follistatin, showed an association with frailty. However, ROC analysis revealed that the AUC of both molecular biomarkers, whether alone or together, were lower than those found for 8TUG or GS in this and other studies.[38,39] Considering the simplicity and low cost of performing the physical tests, it seems unlikely that these biomarkers may replace them in the diagnosis of frailty. Nevertheless, when GS or 8TUG tests cannot be performed due to the patient's status or logistical reasons, myostatin and follistatin quantification could be a helpful tool.

In this study, only the regression model built with myostatin as the independent vari-

ariable was significant for identifying sarcopenia. In addition, ROC curves demonstrated an acceptable ability and high sensitivity of low myostatin concentration for identifying sarcopenia. The AUC obtained in the current analysis was higher than that found in previous studies for interleukin 6, macrophage migration inhibitory factor and insulin-like growth factor, but similar to the AUC obtained by the combination of these serum biomarkers.[40] Nevertheless, other authors[41] have reported that irisin had a higher capacity for predicting sarcopenia than that found for myostatin in the present research.

The specificity of the molecular and physical markers analysed in the present study for identifying frailty or sarcopenia agrees with the idea that there are differences between these conditions, mainly related to muscle mass. Specifically, whereas physical tests identified frailty more accurately, the concentration of serum myostatin, a protein related to muscle growth, was the only variable assessed able to identify sarcopenia.

Given the multifactorial nature of frailty and sarcopenia, composite biomarker indexes would likely be more informative than any single biomarker for early detection of these conditions.[42,43] In particular, activin, GDF11 and GDF15, which are also part of the TFG-β family and are involved in muscle growth, could be good candidates for biomarkers of frailty and/or sarcopenia.[15] It would thus be interesting to test whether analysing also these proteins can increase the capability of the biomarkers assessed in present research to identify frailty and/or sarcopenia.

A major strength of the present study is that we analysed frailty and sarcopenia using validated tools such as the Fried frailty phenotype and the criteria proposed recently by EWGSOP2, including DXA. In addition, we measured two molecular biomarkers related to muscle function with opposite activities, whose relationship to frailty and sarcopenia are yet to be clearly defined. However, we also recognise some limitations within the present research. The sample was limited in its size and we were not able to do a more exhaustive comparison of the groups (ie those with only frailty vs those with only sarcopenia vs those with both conditions vs those without any condition). These comparisons would provide fuller information about the specificity of myostatin for identifying frailty or sarcopenia. Participants were limited to older adults who had experienced recent hospitalisation. Therefore, these results cannot be extrapolated directly to other populations. We analysed only two biomarkers because we were interested in simple and economical alternatives to the current diagnoses of frailty or sarcopenia. However, a wider panel of biomarkers may allow more accurate identification of these conditions. Finally, the cross-sectional nature of the study does not provide information on the capacity of these biomarkers to predict the evolution of frailty or sarcopenia.

In conclusion, the present study shows that whereas myostatin was negatively associated with frailty and sarcopenia, follistatin was positively associated with frailty.

Both proteins had capability to identify frailty but this was lower than that calculated for the 8TUG or the GS tests. Taking into account that tests to confirm the diagnosis of sarcopenia are expensive and of limited availability in many clinical settings, myostatin could be a useful biomarker for identifying sarcopenia in older adults following hospitalisation. However, as the combination of several biomarkers could increase the capability to identify frailty or sarcopenia, further studies that use larger samples and assess myostatin and follistatin together with other biomarkers are warranted.

REFERENCES

1. Fried LP, Tangen CM, Walston J, et al. Frailty in older adults: evidence for a phenotype. *J Gerontol A Biol Sci Med Sci*. 2001;56(3):M146-M156.
2. Cruz-Jentoff AJ, Sayer AA. Sarcopenia. *Lancet*. 2019;393(10191): 2636-2646.
3. Fielding RA, Vellas B, Evans WJ, et al. Sarcopenia: an undiagnosed condition in older adults. Current consensus definition: prevalence, etiology, and consequences. International working group on sarcopenia. *J Am Med Dir Assoc*. 2011;12:249-256.
4. Yilmaz O, Aykent B, Bahat G. Small, however significant differences in the definition of physical frailty, and sarcopenia. *Eur J Intern Med*. 2019;61:e9.
5. Calvani R, Picca A, Landi F, Cesari M, Marzetti E. In reply to "Small, however significant differences in the definition of physical frailty and sarcopenia". *Eur J Intern Med*. 2019;61:e10e11.
6. Lopes-Cunha AI, Veronese N, Melo-Borges S, et al. Frailty as a predictor of adverse outcomes in hospitalized older adults: a systematic review and meta-analysis. *Ageing Res Rev*. 2019;56:100960.
7. Aranha ANF, Smitherman HC, Patel D, et al. Association of hospital readmissions and survivability with frailty and palliative performance scores among long-term care residents. *Am J Hosp Palliat Med*. 2020;37(9):716-720.
8. O'Brien S, Kavanagh RG, Carey BW, et al. The impact of sarcopenia and myosteatosis on postoperative outcomes in patients with inflammatory bowel disease. *Eur Radiol Exp*. 2018;2:37.
9. Yoo SZ, No MH, Heo JW, et al. Role of exercise in age-related sarcopenia. *J Exerc Rehabil*. 2018;14(4):551-558.
10. Guglielmi G, Ponti F, Agostini M, et al. The role of DXA in sarcopenia. *Aging Clin Exp Res*. 2016;28(6):1047-1060.
11. Pinheiro PA, Carneiro JA, Coqueiro RS, et al. “Chair Stand Test” as simple tool for sarcopenia screening in elderly women. *J Nutr Health Aging*. 2016;20(1):56-59.
12. Lee L, Patel T, Costa A. Screening for frailty in primary care. Accuracy of gait speed and hand-grip strength. *Can Fam Physician*. 2017;63:e51-e57.
13. Savva GM, Donoghue OA, Horgan F, et al. Using Timed Up-and-Go to identify frail members of the older population. *J Gerontol A Biol Sci Med Sci*. 2013;68(4):441-446.
14. Cesari M, Landi F, Vellas B, et al. Sarcopenia and physical frailty: two sides of the same coin. *Front Aging Neurosci*. 2014;6:192.
15. White TA, LeBrasseur NK. Myostatin and sarcopenia: opportunities and challenges – a mini-review. *Gerontology*. 2014;60:289-293.
16. Yarasheski KE, Bhasin S, Sinha-Hikim I, et al. Serum myostatin-immunoreactive protein is increased in 60–92 year old women and men with muscle wasting. *J Nutr Health Aging*. 2002;6(5):343-348.
17. Fife E, Kostka J, Kroc L, et al. Relationship of muscle function to circulating myostatin, follistatin and GDF11 in older women and men. *BMC Geriatrics*. 2018;18:200
18. Bergen HR, Farr JN, Vanderboom PM, et al. Myostatin as a mediator of sarcopenia versus homeostatic regulator of muscle mass: insights using a new mass spectrometry-based assay. Skelet Muscle.2015;5:21.

19. Arrieta H, Hervas G, Chloe Rezola-Pardo C, et al. Serum myostatin levels are higher in fitter, more active, and non-frail long-term nursing home residents and increase after a physical exercise intervention. *Gerontology*. 2019;65:229-239.
20. Lee SJ, Lee YS, Zimmers TA, et al. Regulation of muscle mass by follistatin and activins. *Mol Endocrinol*. 2010;24(10):1998-2008.
21. Liaw FY, Kao TW, Fang WH, et al. Increased follistatin associated with decreased gait speed among old adults. *Eur J Clin Invest*. 2018;46:321-327.
22. Ratkevicius A, Joyson A, Selmer I, et al. Serum concentrations of myostatin and myostatin interacting proteins do not differ between young and sarcopenic elderly men. *J Gerontol A Biol Sci Med Sci*. 2011;66:620-626.
23. Negaresh R, Ranjbar R, Baker JS, et al. Skeletal muscle hypertrophy, insulin-like growth factor 1, myostatin and follistatin in healthy and sarcopenic elderly men: the effect of whole body resistance training. *Int J Prev Med*. 2019;10:29.
24. Amasene M, Besga A, Echeverria I, et al. Effects of leucine-enriched whey protein supplementation on physical function in post-hospitalized older adults participating in 12-weeks of resistance training program: a randomized controlled trial. *Nutrients*. 2019;11(10):2337.
25. Echeverria I, Amasene M, Urquiza M, et al. Multicomponent physical exercise in older adults after hospitalization: a randomized controlled trial comparing short- vs. long-term group-based interventions. *Int J Environ Res Public Health*. 2020;17(2):666.
26. Simera I, Moher D, Hoey J, Schulz KF, Altman DG. A catalogue of reporting guidelines for health research. *Eur J Clin Invest*. 2010;40(1):35-53.
27. Folstein MF, Folstein SE, McHugh P-M. Mini-mental state. A practical method for grading the cognitive state of patients for the clinician. *J Psychiatr Res*. 1975;12:189-198.
28. Charlson ME, Pompei P, Ales KL, MacKenzie CR. A new method of classifying prognostic comorbidity in longitudinal studies: development and validation. *J Chronic Dis*. 1987;40(5):373-383.
29. Guigoz Y, Lauque S, Vellas BJ. Identifying the elderly at risk for malnutrition. The mini nutritional assessment. *Clin Geriatr Med*. 2002;18:737-757.
30. Chumlea WC, Roche AF, Steinbaugh ML. Estimating stature from knee height far person 60 to 90 years of age. *J Am Geriatr Soc*. 1985;13:761-765.
31. Fess EE. Grip strength. In: Casanova JS, Ed., *Clinical Assessment Recommendations*, 2nd ed. Chicago: American Society of Hand Therapists; 1992:41-45.
32. Rikli RE, Jones CJ. *Senior Fitness Test Manual*. Champaign, IL: Human Kinetics. 2013.
33. Bohannon RW, Andrews AW, Thomas MW. Walking speed: reference values and correlates for older adults. *JOSPT*. 1996;24:86-90.
34. Cruz-Jentoft AJ, Bauer BG, Bauer J, et al. Writing group for the European Working Group on Sarcopenia in Older People 2 (EWGSOP2), and the extended group for EWGSOP2, sarcopenia: revised European consensus on definition and diagnosis. *Age Ageing*. 2019;48:16-31.
35. Youden WJ. Index for rating diagnostic tests. *Cancer*. 1950;3:32-35.
36. Mafi F, Biglari S, Ghardashi Afousi A, Gaeini AA. Improvement in skeletal muscle strength and plasma levels of follistatin and myostatin induced by an 8-week resistance training and epicatechin supplementation in sarcopenic older adults. *J Aging Phys Act*. 2019;27(3):384-391.
37. Mariot V, Joubert R, Hourde C, et al. Downregulation of myostatin pathway in neuromuscular diseases may explain challenges of anti-myostatin therapeutic approaches. *Nat Commun*. 2017;8:1859.
38. Diez-Ruiz A, Bueno-Errandonea A, Nunez-Barrio J, et al. Factors associated with frailty in primary care: a prospective cohort study. *BMC Geriatrics*. 2016;16:91.
39. Pamoukdjiana F, Paillaud E, Zelek L, et al. Measurement of gait speed in older adults to identify complications associated with frailty: a systematic review. *J Geriatr Oncol*. 2015;6:484-496.
40. Kwak JY, Hwang H, Kim SK, et al. Prediction of sarcopenia using a combination of multiple serum biomarkers. *Sci Rep*.2018;8(1):8574.

41. Chang JS, Kim TH, Nguyen TT, et al. Circulating irisin levels as a predictive biomarker for sarcopenia: a cross-sectional community- based study. *Geriatr Gerontol Int*. 2017;17(11):2266-2273.
42. Calvani R, Marini F, Cesari M, et al. Biomarkers for physical frailty and sarcopenia: state of the science and future developments. *J Cachexia Sarcopenia Muscle*. 2015;6:278-286.
43. Cardoso AL, Fernandes A, Aguilar-Pimentel JA, et al. Towards frailty biomarkers: candidates from genes and pathways regulated in aging and age-related diseases. *Ageing Res Rev*. 2018;47:214-277

5.

EZTABAIDA OROKORRA

DISCUSSION

5. EZTABAIDA OROKORRA / DISCUSSION

Ikerlan honetan, ospitalizazio bat pairatu osteko hirugarren adineko pertsonetan ariketa fisikoan oinarritutako esku-hartze bana aztertu dira. Esku-hartze bakoitzak gainbegiratu (ospitalean talde-saioak) eta gainbegiratu gabeko (etxean banakako saioak) aldi desberdinak izan dituzte. Alde batetik, populazio honetan ariketa fisikoko programa batean parte hartzeari uko egiteko dituzten arrazoiak identifikatu zein aztertu nahi genituen. Bestetik, ospitalizazioa pairatu duten helduetan osagai anitzeko ariketa fisikoko bi esku-hartzeren onurak alderatzeko helburua genuen. Jarraian, hauskortasun eta sarkopenian osagai anitzeko ariketa fisikoko bi esku-hartzeren onurak aztertu eta alderatzea genuen helburu. Azkenik, hauskortasun eta sarkopenian miostatina eta folistatina bezalako bi biomarkatzaileen arteko lotura aztertu eta bi proteina horiek hauskortasuna eta/edo sarkopenia identifikatzeko duten gaitasun alderatu nahi izan genituen. Helburu hauei erantzuna emateko asmoz, jarraian helburu hauei loturiko emaitzen eztabaida orokorra gauzatuko da.

Adineko pertsonak ariketa fisikoko programetan atxikitzeko zailtasunak oso nabarmenak dira; hala ere, ospitalizazio osteko interbentzioetan parte hartzea eragozten duten ezaugarri klinikoei buruzko informazioa mugatua da (Deer eta lank., 2018). Gure ikerketak argi adierazten du helduek interes gutxi dutela ospitaleratze osteko ariketa fisikoko programetan parte hartzeko, eta parte ez hartzeko arrazoiak parametro fisiko, nutrizional eta sozialekin bat egiten dutela. Era berean, adinean gora egiteak, egoera nutrizional eskasa eta etxebizitzan irisgarritasun arazoak izateak, parte ez hartzearen iragarleak direla ere ondorioztatu da. Ariketa fisikoan oinarrituriko programa batean parte hartzeko oztopoetan zentratzen bagara, adierazi beharra dago ospitaleratze ondorengo programa gehienak bihotz eta odol hodietako edo biriketako errehabilitazioa jorratzen dauden gaixoetan egiten direla, edota aldaka zein belauneko ebakuntzaren ondoren (Benzo eta lank., 2015; Ruano-Ravina eta lank., 2016). Programa hauetan jasotako parte-hartze tasak (% 30-70), orokorrean, gure programarenak baino altuagoak dira (Benzo eta lank., 2015; Ruano-Ravina eta lank., 2016). Baliteke desberdintasun honen gakoa, aipaturiko tratamenduen ondoren, ariketa fisikoa errehabilitazioaren funtsezko zatitzat hartzen dela izatea. Hau gertatzen da European Society of Cardiology (Piepoli eta lank., 2010), American Thoracic Society, eta European Respiratory Society (Spruit eta lank., 2013) elkarteek ospitalizazio ostean, ariketa fisikoa oso gomendagarria dela diotelako, eta normalean horri eskerrak, pazienteek honelako programa batean parte hartzea onuragarritzat dute; eta ondorioz programan sartzea onartzen dute. Baina gure ikerketaren ospitaleratze arrazoi antzekoa (batez ere infekzioak) duten adineko pazienteei (geriatrikoei) dagokionez, esan beharra dago sarritan ez dutela esku-hartzea onuragarritzat hartzen. Egia da aurretiaz eginiko

ikerketetan parte-hartze tasa altuagoak izan zirela; hala ere, interbentzio horietako parte-hartzaileak, gure ikerketarekin alderatuz, zertxobait gazteagoak ziren (Brovold eta lank., 2013; Deer eta lank., 2018). Halaber, gure ikerketako partaidetza-tasa, komunitatean bizi ziren baina antzeko ezaugarriak zituzten hirugarren adinekoekin eginiko beste ikerlanetan emandakoaren antzekoa, % 7.3-13 bitarte, izan da (van der Deijl eta lank., 2014). Aipatzekoa da, gure ikerketan, pazienteen erdiek parte ez hartzeko arrazoi nagusia ariketa fisikorako interes falta izan zela. Interes falta hau adineko beste populazio heldu batzuen artean deskribatua ageria da, populazio honek ez baititu jarduera fisikoaren onura positiboak ezagutzen (Guerin eta lank., 2008; Chen, 2010). Adinduen populazioetan beste oztopo batzuk, hala nola gizarte-eragina edo izaera sozialagoa dutenak ere ageri dira, besteak beste, norbanakoaren estimulurik eza, muga fisikoak (mina edo eragozpenak) edo auto-efikazioa baxua (Hill eta lank., 2011; Ferguson eta lank., 2019). Horrexegatik, auzi hau dela eta, osasun-profesionalek pazienteei ospitaleratzearekin lotutako narriadura fisiko zein kognitiboei buruz informatzeko (Graf, 2006; Mathews eta lank., 2014), eta baita ospitaleratze baten ondorio kaltegarri horiek zuzentzeko ariketa fisikoaren onurei buruz informatzeko ere, funtsezko papera jokatu ahal izango dute (Martínez-Velilla eta lank., 2019). Arrazoi hauengatik, beharrezkoa da ospitalizazio ostean, tratamendu egituratu baten parte gisa, pazienteak aktiboki ariketa fisikoko programetan sar daitezen bultzatzea, eta noski, pazienteen pertzepzioak eta konpromiso-faktoreak populazio honentzako ariketa interbentzioak diseinatzerakoan kontuan hartzea.

Aurrez adierazitakoaz gain, konturatu ginen, etxeko irisgarritasun eskasa ariketa fisikoko programetan parte ez hartzeko faktore independentea zela. Emaitza hau beste ikerketa kualitatibo batzuekin bat dator, non irisgarritasun edota ingurumen oztopoek ariketa programetan atxikimendua lortzea eragozten duten (Franco eta lank., 2015). Normalean, irisgarritasun eskasa estatus sozioekonomiko baxuagoarekin lotuta dago, zein, osasun emaitza negatiboen iragarle garrantzitsuenetako bat den (Kollia eta lank., 2018). Gainera, ariketa-programan parte hartu nahi ez zutenen laurdenarentzat garraio arazoa erabaki horren arrazoi gisa helarazi zuten. Emaitza hau bat dator garraiorako sarbide eskasa oztopotzat definitzen duten beste ikerketa batzuekin, hau da, adineko pertsonak jarduera fisikoaren parte-hartzearen oztopo bezala (Franco eta lank., 2015). Hau dena kontuan izanik, ariketa fisikoko programetan egoera ekonomiko baxuagoa duten pertsonen parte-hartze handiagoa lortzeko eta bertaratu behar diren instalazioetara garraioa izateko zein erraztasun ekonomikoak emateko ahalegin bereziak egin behar direla argi geratu da.

Ospitale-altari aplikatutako osagai anitzeko ariketa fisikoko bi esku-hartzeek parte-hartzaileen funtzio fisiko- eta nutrizio-egoerari onura nabarmenak ekarri zizkieten, eta

ospitalizazioari lotutako gainbehera funtzionalari aurre egin zioten. Emaitzek iradokitzen dute, halaber, osagai anitzeko sei asteko ariketa fisikoa egitea nahikoa dela ospitalizazioarekin lotutako narriadura funtzional eta nutrizionala alderantzikatzeko eta/edo lehengoratzeko. Kontrol-talderik ez geneukala kontuan hartuta, baliteke, besterik gabe, ospitaleratu ondoren izandako hobekuntza fisikoak egoera akutua gainditzeagatik izana. Hala ere, aurretiazko ikerketek frogatu dute esku-hartze fisikorik ezean, SPPBren puntuazioa, ondorioz egoera funtzionala, ospitaleratu ondorengo hilabeteetan ez dela nabarmen hobetzen (Timonen eta lank., 2002; Vogler eta lank., 2009; Sherrington eta lank., 2014). SPPB-a ezgaitasun arriskua detektatzeko tresna baliagarria da (Guralnik eta lank., 2000), eta ospitaleko alta jaso ondoren emaitza eskasak izateko arrisku handia duten helduak identifikatzeko informazio pronostiko garrantzitsua ematen du (Volpato eta lank., 2011). Ikerketa honetan, bi esku-hartzeen lehen 12 asteetan SPPB-aren puntuazioa bi puntu inguru handitu zen (puntu bakarra klinikoki esanguratsua izanik) (Perera eta lank., 2006) eta hobekuntza hauek hurrengo 12 asteetan (etxean egin beharreko periodoa) mantendu ziren. Beraz bi esku-hartzeak jorratu ondoren eta funtzio fisikoan izandako hobekuntzak ikusirik, argi adierazi daiteke garaturiko programak ospitaleko alta jaso ondoren emaitza eskasak izateko arriskua murrizteko eraginkorrak direla.

Ospitalizazio ostean (alta eman ondoren) funtzio fisikoa leheneratzeko helburuarekin ariketa fisikoko programak ebaluatzen dituzten ikerketek, hauen jorratzearen onurei buruz, emaitza kontraesankorrak eman dituzte. Emaitzen kontraesan hori esku-hartze mota (talde saioak versus bakarkako saioak etxean) eta pazienteen patologiek azal lezakete. Gure emaitzak aurreko lanekin bat datoz; izan ere, talde saioetan oinarritutako osagai anitzeko programak ospitaleratzeari lotutako narriadura funtzionala hobetzeko edo leheneratzeko eraginkorrak dira (Timonen eta lank., 2002). Kontrara, etxean oinarritutako esku-hartzeek emaitza apalagoak erakusten dituzte (Vogler eta lank., 2009; Hill eta lank., 2015; Tsekoura eta lank., 2018). Etxean oinarritutako programetan funtzio fisikoan hobekuntza handiagoak lortzeko gainbegiratze maila garrantzitsua da (Hill eta lank., 2015; Lacroix eta lank., 2016; Tsekoura eta lank., 2018). Autore batzuen ustez, etxean oinarritutako programek indarrean duten eragin txikiagoa etxeko inguruneak intentsitate nahikoa duten programak jorratzeko sortzen dituen zailtasunetan oinarritzen da (Vogler eta lank., 2009). Hala eta guztiz ere, pazienteen funtzio fisikoan eta eguneroko bizimoduaren jardueretan berreskuratze edo hobekuntza onuragarriagoak izateko, ospitaleratze-aldian hasitako ariketa fisikoko esku-hartzea, etxean egindako batekin jarraitzea iradoki izan da (DeVito eta lank., 2003; Kosse eta lank., 2013). Etxean gauzatutako periodoan, taldean oinarritutako periodoan funtzio eta jarduera fisikoan lortutako hobekuntzak mantentzea lortu zen. Gure

emaitzak aurretiazko ikerlanekin bat datoz. Horien arabera, jarraipenerako etxera gauzaturiko bisitak eta telefono-deiak etxean oinarritutako esku-hartzeak betetzeko atxikimenduari eusteko eraginkorrak dira (Kosse eta lank., 2013; Tsekoura eta lank., 2018) .

Parte-hartzaile gehienak interbentzioaren hasieran malnutrizioa jasateko arriskuan zeuden bitartean, 12 asteren ondoren, nutrizio-egoera ona zutenek desnutrizio-arriskua zutenak gainditu zituzten, eta MNA testaren arabera, subjektu bakar bat zegoen desnutrizioan. Nutrizio-hobekuntza hori nabarmen mantendu zen hurrengo hiru hilabeteetan. Gure ezagutzarako, hau da lehen ikerlana ospitaleratze ondorengo esku-hartzeak MNA-n (egoera nutrizionala) dituen ondorioak deskribatzen dituena. Hala ere, beste populazio batzuetan egindako ikerketek egoera nutrizionala hobetzeko ariketa fisikoaren eraginkortasuna erakutsi dute (Timmerman eta lank., 2012). Gure emaitzek aurretik aipatutakoarekin antzekotasunak azaleratu dituzte, hots, bi taldeetako parte-hartzaileek esku-hartzearen amaieran nutrizio-egoera maila onargarri baten barruan bukatu zuten, beraz ariketa fisikoa ospitaleratu ondoren adineko helduen nutrizio-egoera hobetzeko tresna erabilgarria izan daitekeela iradokiz. MNA-ren hobekuntzak bereziki aipagarriak direla esan beharra dago, batez ere nutrizio-egoera zein funtzio fisikoan emaitza positiboak izateak (Blanc-Bisson eta lank., 2008; Dent eta lank., 2019), eguneko jarduerak murrizteak (Gill eta lank., 2010) eta parte-hartzaileen gizarte-isolamenduak (Robins eta lank., 2018) eragin ditzaketen emaitza kaltegarri batzuekin zerikusia duten faktoreen babesletzat hartzen direlako. Faktore horiek eragin negatiboa izan dezakete helduen autonomian eta bizi kalitatean, eta, askotan, ez dira hautematen. Taldeen artean bizi kalitatearen gaineko efektuetan desberdintasun txikiak egon dira. ELA-k 12 asteren buruan igoera nabarmena izan zuen, hain zuzen ere taldean oinarritutako aldia amaitu zenean. Aipatu beharra dago EMA-k sei aste lehenago amaitu zuela taldean oinarritutako programa. Aitzitik, ELA-n etxean oinarritutako aldian, bizi kalitateak behera egin zuen. Emaitza horiek iradokitzen dutenez, taldeetan oinarritutako esku-hartzeak etxean oinarritutakoak baino egokiagoak izan daitezke bizi kalitatea hobetzeko, minbizia duten (Buffart eta lank., 2017) pazienteetan eta sarkopenia duten adineko pertsonetan proposatzen den bezala (Tsekoura eta lank., 2018). Taldeko esku-hartzeetan gizarte-elementu bat egoteak desberdintasun hori azal lezake. Hala ere, gure emaitzetan talde-interakziorik ez dugunez lortu, edozein interpretazio egitearekin zuhurrak gara; datu gehiago behar dira behaketa hori argitzeko.

Bi esku-hartzeen eraginkortasuna funtzio fisiko eta nutrizio-egoeran zentratuz konparatzen dugunean, esan genezake epe luzeko adarra ez zela epe laburreko adarra baino eraginkorragoa izan. Ospitalean sei asteko talde saioak, eta, ondoren, etxean 18

asteko banakako saioak erakutsi zuten nahikoa zela goiko eta beheko gorputz-adarraren indarra, abiadura, oreka estatikoa eta dinamikoa, gaitasun funtzionala, erresistentzia aerobikoa, jarduera fisikoa eta nutrizio-egoera hobetzeko.

Hauskortasunari dagokionez, lehen 12 asteetan, ospitale-altari aplikatutako osagai anitzeko ariketa fisikoa egiteko bi esku-hatzeek onura esanguratsu eta baliokideak eman zituzten. Eta ondorioz gure esku-hartzeak ospitaleratu ondoko adineko pazienteentzat seguruak direla frogatu genuen. Emaitzek iradokitzen dute, halaber, ospitalizazioari lotutako narriadura funtzional eta nutrizionalean deskribatu dugun bezala, sei asteko iraupena duen talde saioak egitea nahikoa dela hauskortasuna leheneratzeko. Bi esku-hartzeek nabarmen murriztu zuten hauskortasuna. Hasieran, Fried-en Frailty Index arabera, 36 pazienteetatik 23 hauskorrak ziren eta, bukaeran (12.astea) hiruk bakarrik zuten hauskortasun-egoera. Hauskortasun irizpide bakoitza betetzen zuten pazienteen kopuruak ere behera egin zuen, EMA-n akiduran, moteltasunean eta jarduera baxuan eta ELA-n moteltasunean izan ziren murrizketa nabarmenenak. Ondorioz, 12 asteetan Fried-en indizearen batezbestekoa, hurrenez hurren EMA-n eta ELA-n % 56 eta % 64 murriztu zen.

Hauskortasuna sindrome multisistemiko konplexua da, eta sakonki aldatzen du pazienteak egoera akututik sendatzeko duen gaitasuna (De Biasio eta lank., 2020). Edadetu hauskorrak bereziki zaurgarriak dira ospitalizazioaren ondorio kaltegarrien aurrean, batez ere funtzio fisikoaren narriaduraren aurrean (Merchant eta lank., 2021). Gaitasunak gutxitze horrek altaren ondorengo hilabeteetan ere jarrai dezake (Chen eta lank., 2008]. Ildo horretatik jarraiki, eta epe luzera begiratuz, azterlan batek ikusi zuen altatik 3 hilabetera muskulu-masa, muskulu-indar eta pazienteen errendimendu fisikoak ez zituztela populazioaren batez besteko mailak lortzen (Aarden eta lank., 2020). Hori gutxi ez balitz, beste azterketa baten arabera, ospitaleratu eta urtebetera ere izandako gainbehera funtzonal hori mantendu daiteke (Gill eta lank., 2010). Beraz aurrez adierazi bezala, gure emaitzek erakutsi zuten ospitaleratu ondoko pazienteentan hauskortasuna lehengoratu daitekeela. Ondorio hori klinikoki garrantzitsua da, hauskortasun leunduak ospitalizazioarekin lotutako kontrako gertaeren arriskua murriztu baitezake, hala nola, berrospitaleratzeak, mendekotasuna, instituzionalizazioa eta baita heriotza ere. Aurretik beste aldagai fisiko batzuetan deskribatu bezala hauskortasunaren prebalentziaren murrizketan taldeen artean desberdintasunik lortu ez dugun arren, egia da moteltasunaren (martxaren abiadura) irizpidean taldeen arteko konparaketa ELA-ren alde dagoela. Horren arrazoia etxeko programetan funtzio fisikoan hobekuntza handiagoak lortzeko gainbegiratze-maila garrantzitsua dela izan daiteke (Lacroix eta lank., 2016; Tsekoura eta lank., 2018).

Sarkopeniari dagokionez, bi taldeetako batean ere ez zen hobekuntza nabarmenik lortu. Emaitza hauek bat datoz berriki argitaratu den argitalpen batean; autoreek ondorioztatu dutenez, badirudi ariketa fisikoko programak aplikatzeak sindrome horren ondorio nagusietako batzuk indargabetzen dituela, hala nola, indarra gutxitzea eta errendimendu fisikoa. Hala ere, probak ez dira aski muskulu-masan efektu bat dagoen edo ez bermatzeko (Escriche-Escuder eta lank., 2021). Sarkopeniaren trataeran baliteke ariketa fisikoa bera bakarrik nahikoa ez izatea; akaso horregatik osagai anitzeko ariketa-programak eta interbentzio nutrizionalak konbinatzea bultzatzen duten esku-hartze multimodalak eraginkorragoak izan daiteke (Cruz-Jentoft eta lank., 2017; Nascimento eta lank., 2019, Han eta lank., 2020).

Arreta parte-hartzaileak sarkopenirako hautagai gisa sailkatzeko bi irizpideetan jartzen badugu, bi taldeetan alde txiki bat ikusiko dugu. Hauskortasunaren ebaluazioan gertatu bezala, ez da heltzeko indarra hobetzea lortzen, baina gorputzaren behealdeko indarra hobetzeko joera positiboa dago. Hau izan liteke. izan ere, eskuaren eta besaurrearen euste-indarra ez delako adinekoentzako indar ariketa programa bati erantzunez muskulu-funtzioan gertatzen diren aldaketak ebaluatzeko neurri klinikoki garrantzitsu eta/edo baliagarria (Bourdel-Marchasson eta lank., 2001; Leenders eta lank., 2013). Osagai anitzeko ariketa eraginkorra izan liteke sarkopeniaren kasuan funtzio fisikoaren narriadurari aurre egiteko. Hala ere, ez dago argi ariketa-programa hori eraginkorra ote den sarkopenia duten pertsonen muskulu-masa handitzeko (Makizako eta lank., 2020 Escriche-Escuder eta lank., 2021). Gainera, DXA neurketan gure lagin-tamaina hauskortasunaren ebaluazioan baino txikiagoa izan da eta metodologia horren bidez gorputz-osaeran izandako 1,0 kg-tik beherako aldeak ezin dira hauteman (Tieland eta lank., 2012). Baliteke, interbentzioaren eragina eta zahartzearekin eta sarkopeniarekin lotutako muskulu-masaren eta muskulu-indarraren murrizketaren prebentzioa argitzeko, lagin-tamaina handiagokoak diren azterketa gehiago egin behar izatea.

Sarkopenia eta hasukortasuna alde batera utzi gabe, baina zehazki biomarkatzaileen bidez hauen identifikazioan murgilduta jarraituko dugu. Esan genezake, emaitzetan ikusten denez, hauskortasuna edo sarkopenia zuten parte-hartzaileetan miostatina kontzentrazio seriko txikiagoa izan zuteela, eta folistatina altuagoa zela hauskortasuna zutenetan. Erregresio-ekuazioek eta hartzailearen ezaugarri operatiboaren (ROC) kurbek adierazi zutenez, biomarkatzaile molekularrek baino ahalmen handiagoa zuten ibilera abiadura eta 8TUG (altxa, ibili, bira eta eseri) probek hauskortasuna identifikatzeko. Miostatina izan zen sarkopenia modu esanguratsuan identifikatzeko gai zen biomarkatzaile bakar ebaluatua.

Miostatinak eta folistatinak kontrako funtzioak dituzte: miostatinak muskulu eskeletikoan proteolisia handitu eta proteinen sintesia inhibitzen du (White eta lank.,

2014), eta folistatinak aldiz muskulu-hazkuntza sustatzen du (Lee eta lank., 2010). Gure emaitzak ez datoz bat proteina bakoitzaren funtzioarekin. Hain zuzen, miostatina eta hauskortasunaren edo sarkopeniaren artean erlazio/lotura negatiboa antzeman zen, eta folistatina eta hauskortasunaren arteko erlazio/lotura positiboa hauteman zen. Hori bat dator aurretiazko ikerketa batzuekin (Bergen eta lank., 2015; Liaw eta lank., 2016; Arrieta eta lank., 2019), baina ez beste batzuekin. Non, funtzio fisiko okerragoa zuten pertsonetan miostatina kontzentrazioa altua zen (White eta lank., 2014) eta erresistentzia-entrenamenduaren ondoren folistatina altuago eta miostatina baxuago zutela adierazi zen (Mafi eta lank., 2016).

Zirkulazio mailan muskulu-galera sindromea dituzten gaixoetan miostatina baxua eta folistatina altua identifikatu ziren; horrek adierazi lezake bi proteinek muskulu-galera handiagoa murrizteko barne-mekanismo batean parte har dezaketela (Mariot eta lank., 2017). Ildo horretatik joaz, zenbait autorek proposatu dute miostatinak “txalona” gisa joka dezakeela, aurkako egoera metabolikoei erantzuteko muskulu-hazkunde eskeletikoa murriztuz, eta hazkundea inhibitzeko beharrik ez dagoenean bere jarduera gutxituz (Fife eta lank., 2018).

Erregresio-ereduetan, proba fisikoen errendimenduak eta miostatinaren eta folistatinaren kontzentrazio serikoak hauskortasunarekin lotura erakutsi zuten. Hala ere, ROC kurben analisiaren arabera, bi biomarkatzaile molekularren kurba azpiko areak (AUC), bakarrik zein batera eta azterlan honetan zein beste batzuetan 8TUG edo ibilera abiadura probetan aurkitutakoak baino txikiagoak ziren (Pamoukdjian eta lank., 2015; Diez-Ruiz eta lank., 2016). Proba fisikoak aurrera eramateko sinpletasun eta kostu txikia kontuan hartuta, ez dirudi erabilitako biomarkatzaileek hauskortasun baheketan hauek ordezkatzerik izango dutenik. Hala ere, pazientearen egoera edo arrazoi logistikoak direla eta, ibilera abiadura edo 8TUG probak egiterik ez dagoenean, miostatinaren eta folistatinaren kuantifikazioa tresna erabilgarri zein lagungarria izan daiteke.

Azterlan honetan, sarkopenia identifikatzeko miostatina aldagai independente gisa eraikitako erregresio-eredua baino ez zen esanguratsua izan. Gainera, ROC kurbek miostatina-kontzentrazio baxuak sarkopenia identifikatzeko ahalmen onargarria eta sentikortasun handia duela erakutsi zuten. Gure analisian lortutako AUC-a aurretiazko ikerketetan interleuzina 6, makrofagoen migrazioaren faktore inhibitzaile eta intsulina bezalako hazkunde-faktorearentzako baino handiagoa izan zen; baina biomarkatzaile seriko horien konbinazioak lortutako AUC-aren antzekoa (Kwak eta lank., 2018). Beste autore batzuek ordea (Chang eta lan., 2017), adierazi dute sarkopenia iragartzeko irisinak ikerketa honetan miostatinari aurkituriko baino gaitasun handiagoa duela.

Ikerketa honetan hauskortasuna edo sarkopenia identifikatzeko aztertutako markatzaile molekular zein fisikoen espezifikotasunak bat datoz baldintza horien artean, batez ere muskulu-masarekin lotuta, desberdintasunak daudelako ideiarekin. Konkretuki, proba fisikoek hauskortasuna zehaztasun handiagoz identifikatu zuten bitartean, miostatina serikoaren kontzentrazioa (muskulu-hazkundearekin lotutako proteina bat), ebaluatutako aldagaietatik sarkopenia identifikatzen bakarra izan zen. Hauskortasunaren eta sarkopeniaren izaera multifaktoriala dela eta, seguruenik, biomarkatzaile konposatuen indizeek baldintza horiek goiz detektatzeko edozein biomarkatzaile indibidualek baino informazio gehiago emango lukete (Calvani eta lank., 2015; Cardoso eta lank., 2018). Zehazki, aktibina, GDF11 eta GDF15 biomarkatzaileak, TFG-β familiaren parte direnak eta muskulu-hazkundean parte hartzen dutenak, hauskortasun eta/edo sarkopeniaren baheketarako hautagai onak izan daitezke (White eta lank., 2014). Beraz, hauskortasuna eta/edo sarkopenia identifikatzeko interesgarria litzateke egiaztatzea ea proteina horien analisiak ere ikerketa honetan ebaluatutako biomarkatzaileen gaitasuna handitu dezaketen

5.1. MUGAK, INDARGUNEAK ETA ETORKIZUNERAKO PROPOSAMENAK

5.1.1. Ikerketako mugak

Alde batetik, ikerketa kontrol talderik gabe eraman zen aurrera, hori izan bagenu aukera izango genukeen ariketa fisikoa egiten ez duten pertsona nagusien emaitzekin konparatzeko. Eta are gehiago, talde kontrol hori izateak aukera emango liguke egoera akutu batean egon ostean eman diren hobekuntzak ziurtasunez programarenak edo berezkoak (egoera igaro delako) diren jakiteko.

Beste aldetik, ikerketa honetan dagoen partaide kopurua txikia da, batez ere ezezkoekin konparatzen baditugu, lehen zein bigarren mailako emaitzetan garrantzi estatistikoa lortzeko arazoak sortuz. Hala ere, argi izan behar dugu ospitalizaturik dauden pertsona nagusien errekrutamendua ez dela batere eginkizun erraza.

Horrez gain eta bukatzeko, nahiz eta funtzio fisikoko hainbat testek hobekuntzak sendoak izan zirela erakutsi, kontuan izan behar da esku-hartzean erabilitako ariketetako batzuk lehen mailako emaitzen antzekoak direla.

5.1.2. Indarguneak eta etorkizuneko proposamenak

Ikerketa proiektu honen indarguneei dagokienez, ez dugu ahaztu behar ikerketa gutxik aztertu dituztela ospitalizazioaren ondoren adineko pertsonekin (beraien tratamenduaren barne egon gabe) ariketa-programek zer nolako eragina duten. Baita ere adierazgarria da aipatzea, ikerketa hau ospitalizazio ostean adinduekin osagai anitzeko eta aldi desberdinak (taldekako saioak ospitalean + etxean bakarkako ariketak) bateratu dituen ariketa programa bat aurrera eraman duen lehen ausazko entsegu klinikoa izan dela.

Ikerketa honetan lortutako emaitzek beste artikulu zientifiko zein ikerketa batzuk sustatzeko aukera sortzen dute. Lehenengo eta behin, jaso diren beste aldagai gehiago aztertzea (elikadura, loa, odol analitikak, depresio eta kognizio eskalak…) interesgarria izango litzateke. Bigarrenik, osagai anitzeko ariketa fisikoko programak eraginkorrak direla ikusi da; baina ez dakigu zenbatera irauten duten hobekuntza horiek edota egonkortzen diren ere. Beraz oso interesgarria izango litzake parte-hartzaileei jarraipen bat (follow-up) egitea. Baina jarraipen hori baiezkoa zein ezezkoa eman zutenetan egitea oraindik ere garrantzitsuagoa da beraien artean desberdintasunik dagoen edo ez ikusteko. Azkenik, esku-hartze goiztiarrak beharrezkoak direla ikasi ahal izan dugu, beraz etorkizuneko beste lerro bat ere litzateke erantzun denbora egokiena zein den aztertzea. Hots, ospitalizazioan zehar eta alta ostean osagai anitzeko ariketa programa bat gauzatzen dituzten bi talde aztertu eta beraien artean konparatu erantzun denbora goiztiarrena eta egokiena zein den ikusteko.

6.

ONDORIOAK

CONCLUSIONS

6. ONDORIOAK / CONCLUSIONS

1. Ikerketa-proiektu honek, ospitalizatu ondoko ariketa fisikoko programa batean pertsona helduek parte-hartze txikia dutela berretsi egin du. Parte ez hartzea adin handiagoarekin, nutrizio-egoera txarrarekin eta etxeko irisgarritasun txikiagoarekin lotuta dago. Ahalegin handiak egin behar dira ariketa fisikoko programetan parte hartzea handitzeko, bereziki parte hartzeko joera txikiena duten populazioetan. Gure aurkikuntzek ariketaren programa onuragarrietan adineko pazienteen parte-hartzea handitzeko faktore horiek kontuan hartuko dituen esku-hartze diseinu baten beharra azpimarratzen dute.

2. Ikerketa-proiektu honetan, ospitalizazioari lotutako narriadurari aurre eginez, ospitale-altan aplikatutako eta taldean zein etxean egindako luzera desberdinetako osagai anitzeko ariketa fisikoko bi esku-hartzeren onurak alderatu ditugu. Bi esku-hartze horiek eraginkorrak direla erakutsi dute. Aurkikuntza horietan oinarrituta, beti ere biak etxean hogeita lau aste bete arte irauten dutenean, taldean egindako sei asteko ariketa fisikoko esku-hartzeak hamabi astekoaren antzeko onura funtzionala eta nutriziolanak sortu zituela zehaztu dugu.

3. Bestalde, ikerketa-proiektu honek ospitaleratu ondoren hirugarren adineko pertsonen hauskortasun eta sarkopenian hamabi astez osagai anitzeko bi esku-hartzeren eraginkortasuna konparatu du. Taldean oinarritutako sei asteko osagai anitzeko ariketa fisikoko esku-hartze bat hauskortasuna aldatzeko nahikoa dela zehaztu dugu. Baina sarkopeniaren tratamenduan eta prebentzioan eragina argitzeko, lagin handiagoekin ikerketa gehiago behar direla ondorioztatu dugu. Baita ere, populazio hauskor eta sarkopenikoa, talde- edota etxe-ingurunean ariketa-programa bati erantzuteko gai dela frogatu dugu.

4. Azterlan honen arabera, miostatina hauskortasunarekin eta sarkopeniarekin negatiboki lotzen da, eta follistatina, berriz, hauskortasunarekin positiboki. Miostatina ospitaleratu osteko hirugarren adineko pertsonetan sarkopenia identifikatzeko biomarkatzaile erabilgarria izan daiteke. Haatik, hauskortasuna identifikatzeko proba fisikoek baino gaitasun txikiagoa dauka. Lagin handiagoko eta miokina horiek beste biomarkatzaile batzuekin batera erabiliz azterlan gehiago egitea justifikatzen dela frogatu dugu.

5. Aplikagarritasunari dagokionez aipatu, aurkikuntza hauek ospitalizazio bati jarraiki ariketa fisikoko programa batean adinekoen helgarritasuna eta parte hartzea handitzeko estrategiak islatzen dituztela. Era berean, emaitza horiek ospitaleratu ondoren adinekoek egin ditzazketen ariketa fisikoko interbentzio praktiko, egingarri eta errentagarriak diseinatzeko informazio baliotsua ematen dute.

1. This study confirms low participation of older adults in a post-hospitalization physical exercise program. Non-participation was associated with increased age, poor nutritional status, and reduced home accessibility. Efforts are needed to increase participation in physical exercise programs, specifically in populations that are less prone to participate. Our findings support the need for intervention design that accounts for these factors to increase older patient participation in beneficial exercise programs.

2. In this research project, we compared the benefits of two multicomponent physical exercise interventions implemented at hospital discharge with different group- and home-based period lengths, combating the decline associated with hospitalization in older adults. Both interventions have demonstrated their effectiveness and based on these findings, we determined that six weeks of a group-based exercise intervention caused similar functional and nutritional benefits to a longer group-based intervention of twelve weeks, when both are continued at home until twenty-four weeks.

3. On the other hand, this research project has compared during twelve weeks the effectiveness of two multi-component intervention on frailty and sarcopenia among older adults after hospitalization. We determined that a six-week group-based multicomponent exercise intervention is sufficient to reverse frailty, but further studies using larger samples are warranted to clarify the effect of treatment and prevention of sarcopenia. In addition, it has been shown that frail and sarcopenic population is capable of responding to an exercise program whether in a group-based or a home-based setting.

4. The present study shows that whereas myostatin was negatively associated with frailty and sarcopenia, follistatin was positively associated with frailty. Myostatin may be a useful biomarker for sarcopenia in post-hospitalised older adults. However, it has a lower capability for identifying frailty than physical tests. Further studies using larger samples and these myokines together with other biomarkers are warranted.

5. In terms of implementation, these findings inform strategies to improve accessibility and increase older adult participation in physical exercise programs following hospitalization. Likewise, these results provide valuable information for the design of practical, feasible, and cost-efective physical exercise interventions following hospitalization in older adults.

7.

BIBLIOGRAFIA

BIBLIOGRAPHY

7. BIBLIOGRAFIA / BIBLIOGRAPHY

Aarden, J. J., Reijnierse, E. M., van der Schaaf, M., van der Esch, M., Reichardt, L. A., van Seben, R., Bosch, J. A., Twisk, J., Maier, A. B., Engelbert, R., Buurman, B. M., eta Hospital-ADL study group (2021). Longitudinal Changes in Muscle Mass, Muscle Strength, and Physical Performance in Acutely Hospitalized Older Adults. Journal of the American Medical Directors Association, 22(4), 839–845.e1. https://doi.org/10.1016/j.jamda.2020.12.006

ACSM: American College of Sports Medicine (2009). American College of Sports Medicine position stand. Progression models in resistance training for healthy adults. Medicine and science in sports and exercise, 41(3), 687–708. https://doi.org/10.1249/MSS.0b013e3181915670

ACSM: American College of Sports Medicine. (2013). ACSM's guidelines for exercise testing and prescription. Baltimore, USA: Lippincott Williams & Wilkins.

Aranha, A., Smitherman, H. C., Jr, Patel, D., eta Patel, P. J. (2020). Association of Hospital Readmissions and Survivability With Frailty and Palliative Performance Scores Among Long-Term Care Residents. American Journal of Hospice and Palliative Care, 37(9), 716–720. https://doi.org/10.1177/1049909120907602

Arrieta, H., Hervás, G., Rezola-Pardo, C., Ruiz-Litago, F., Iturburu, M., Yanguas, J. J., Gil, S. M., Rodriguez-Larrad, A., eta Irazusta, J. (2019). Serum Myostatin Levels Are Higher in Fitter, More Active, and Non-Frail Long-Term Nursing Home Residents and Increase after a Physical Exercise Intervention. Gerontology, 65(3), 229–239. https://doi.org/10.1159/000494137

Arrieta, H., Rezola-Pardo, C., Zarrazquin, I., Echeverria, I., Yanguas, J. J., Iturburu, M., Gil, S. M., Rodriguez-Larrad, A., eta Irazusta, J. (2018). A multicomponent exercise program improves physical function in long-term nursing home residents: a randomized controlled trial. Experimental gerontology, 103, 94-100. https://doi.org/10.1016/j.exger.2018.01.008

Bäck, M., Jivegård, L., Johansson, A., Nordanstig, J., Svanberg, T., Adania, U. W., eta Sjögren, P. (2015). Home-based supervised exercise versus hospital-based supervised exercise or unsupervised walk advice as treatment for intermittent claudication: a systematic review. Journal of rehabilitation medicine, 47(9), 801–808. https://doi.org/10.2340/16501977-2012

Badia, X., Roset, M., Montserrat, S., Herdman, M., eta Segura, A. (1999). The Spanish version of EuroQol: a description and its applications. European Quality of Life scale. Medicina clinica, 112 Suppl 1, 79-85.

Benzo, R., Wetzstein, M., Neuenfeldt, P., eta McEvoy, C. (2015). Implementation of physical activity programs after COPD hospitalizations: Lessons from a randomized study. Chronic respiratory disease, 12(1), 5–10. https://doi.org/10.1177/1479972314562208

Berg, K. O., Wood-Dauphinee, S. L., Williams, J. I., eta Maki, B. (1992). Measuring balance in the elderly: validation of an instrument. Canadian journal of public health= Revue canadienne de sante publique, 83 Suppl 2, S7-S11.

Bergen, H. R., 3rd, Farr, J. N., Vanderboom, P. M., Atkinson, E. J., White, T. A., Singh, R. J., Khosla, S., eta LeBrasseur, N. K. (2015). Myostatin as a mediator of sarcopenia versus homeostatic regulator of muscle mass: insights using a new mass spectrometry-based assay. Skeletal muscle, 5, 21. https://doi.org/10.1186/s13395-015-0047-5

Bernard, P., Doré, I., Romain, A. J., Hains-Monfette, G., Kingsbury, C., eta Sabiston, C. (2018). Dose response association of objective physical activity with mental health in a representative national sample of adults: A cross-sectional study. PloS one, 13(10), e0204682. https://doi.org/10.1371/journal.pone.0204682

Bertschi, D., Kiss, C. M., Beerli, N., eta Kressig, R. W. (2021). Sarcopenia in hospitalized geriatric patients: insights into prevalence and associated parameters using new EWGSOP2 guidelines. European journal of clinical nutrition, 75(4), 653–660. https://doi.org/10.1038/s41430-020-00780-7

Biomarkers Definitions Working Group. (2001). Biomarkers and surrogate endpoints: preferred definitions and conceptual framework. Clinical pharmacology and therapeutics, 69(3), 89-95. https://doi.org/10.1067/mcp.2001.113989

Blanc-Bisson, C., Dechamps, A., Gouspillou, G., Dehail, P., eta Bourdel-Marchasson, I. (2008). A randomized controlled trial on early physiotherapy intervention versus usual care in acute care unit for elderly: potential benefits in light of dietary intakes. The journal of nutrition, health & aging, 12(6), 395–399. https://doi.org/10.1007/BF02982673

Blazer, D. G., Yaffe, K., eta Karlawish, J. (2015). Cognitive aging: a report from the Institute of Medicine. Journal of the American Medical Association, 313(21), 2121-2122. https://doi.org/10.1001/jama.2015.4380

Bogle-Thorbahn, L. D., eta Newton, R. A. (1996). Use of the Berg Balance Test to predict falls in elderly persons. Physical therapy, 76(6), 576–585. https://doi.org/10.1093/ptj/76.6.576

Bohannon, R. W., Andrews, A. W., eta Thomas, M. W. (1996). Walking speed: reference values and correlates for older adults. Journal of orthopaedic & sports physical therapy, 24(2), 86-90. https://doi.org/10.2519/jospt.1996.24.2.86

Borg, G. (1970). Perceived exertion as an indicator of somatic stress. Scandinavian Journal of Rehabiitationl Medicine.

Bouillon, K., Kivimaki, M., Hamer, M., Sabia, S., Fransson, E. I., Singh-Manoux, A., Gale, C. R., eta Batty, G. D. (2013). Measures of frailty in population-based studies: an overview BMC geriatrics, 13, 64. https://doi.org/10.1186/1471-2318-13-64

Bourdel-Marchasson, I., Joseph, P. A., Dehail, P., Biran, M., Faux, P., Rainfray, M., Emeriau, J. P., Canioni, P., eta Thiaudière, E. (2001). Functional and metabolic early changes in calf muscle occurring during nutritional repletion in malnourished elderly patients. *The American journal of clinical nutrition*, *73*(4), 832–838. https://doi.org/10.1093/ajcn/73.4.832

Bradley, C. (2013). Trends in hospitalisations due to falls by older people, Australia. Canberra (AUST): Australia Institute of Health and Welfare. Retreived from: https://core.ac.uk/download/pdf/30676566

Brady, A. O., Straight, C. R., eta Evans, E. M. (2014). Body composition, muscle capacity, and physical function in older adults: an integrated conceptual model. Journal of aging and physical activity, 22(3), 441-452. https://doi.org/10.1123/japa.2013-0009

Brovold, T., Skelton, D. A., eta Bergland, A. (2013). Older adults recently discharged from the hospital: effect of aerobic interval exercise on health-related quality of life, physical fitness, and physical activity. Journal of the American Geriatrics Society, 61(9), 1580–1585. https://doi.org/10.1111/jgs.12400

Brzycki, M. (1993). Strength testing—predicting a one-rep max from reps-to-fatigue. Journal of physical education, recreation & dance, 64(1), 88-90.

Buffart, L. M., Kalter, J., Sweegers, M. G., Courneya, K. S., Newton, R. U., Aaronson, N. K., Jacobsen, P. B., May, A. M., Galvão, D. A., Chinapaw, M. J., Steindorf, K., Irwin, M. L., Stuiver, M. M., Hayes, S., Griffith, K. A., Lucia, A., Mesters, I., van Weert, E., Knoop, H., Goedendorp, M. M., … Brug, J. (2017). Effects and moderators of exercise on quality of life and physical function in patients with cancer: An individual patient data meta-analysis of 34 RCTs. Cancer treatment reviews, 52, 91–104. https://doi.org/10.1016/j.ctrv.2016.11.010

Cadore, E. L., Rodríguez-Mañas, L., Sinclair, A., eta Izquierdo, M. (2013). Effects of different exercise interventions on risk of falls, gait ability, and balance in physically frail older adults: a systematic review. Rejuvenation research, 16(2), 105-114. https://doi.org/10.1089/rej.2012.1397

Calvani, R., Marini, F., Cesari, M., Tosato, M., Anker, S. D., von Haehling, S., Miller, R. R., Bernabei, R., Landi, F., Marzetti, E., eta SPRINTT consortium (2015). Biomarkers for physical frailty and sarcopenia: state of the science and future developments. Journal of cachexia, sarcopenia and muscle, 6(4), 278–286. https://doi.org/10.1002/jcsm.12051

Campbell, A.J., Robertson, M. eta Clare. (2003). Otago Exercise Programme to Prevent Falls in Older Adults. Retrieved from: https://hfwcny.org/hfwcny-content/uploads/Otago_Exercise_Programme-Revised.pdf

Campbell, S. E., Seymour, D. G., eta Primrose, W. R. (2004). A systematic literature review of factors affecting outcome in older medical patients admitted to hospital. Age and ageing, 33(2), 110-115. https://doi.org/10.1093/ageing/afh036

Cardoso, A. L., Fernandes, A., Aguilar-Pimentel, J. A., de Angelis, M. H., Guedes, J. R., Brito, M. A., Ortolano, S., Pani, G., Athanasopoulou, S., Gonos, E. S., Schosserer, M., Grillari, J., Peterson, P., Tuna, B. G., Dogan, S., Meyer, A., van Os, R., eta Trendelenburg, A. U. (2018). Towards frailty biomarkers: Candidates from genes and pathways regulated in aging and age-related diseases. Ageing research reviews, 47, 214–277. https://doi.org/10.1016/j.arr.2018.07.004

Carone, G. (2005). Long-term labour force projections for the 25 EU Member States: A set of data for assessing the economic impact of ageing. European Commission Economic Paper, (235). Brussels, Belgium.

Casas-Herrero, A., eta Izquierdo, M. (2012). Physical exercise as an efficient intervention in frail elderly persons. Anales del Sistema Sanitario de Navarra. Gobierno de Navarra, Departamento de Salud. 35(1), 69–85. https://doi.org/10.4321/s1137-66272012000100007

Cesari, M., Kritchevsky, S. B., Newman, A. B., Simonsick, E. M., Harris, T. B., Penninx, B. W., Brach, J. S., Tylavsky, F. A., Satterfield, S., Bauer, D. C., Rubin, S. M., Visser, M., Pahor, M., eta Health, Aging and Body Composition Study (2009). Added value of physical performance measures in predicting adverse health-related events: results from the Health, Aging And Body Composition Study. Journal of the American Geriatrics Society, 57(2), 251–259. https://doi.org/10.1111/j.1532-5415.2008.02126.x

Cesari, M., Kritchevsky, S. B., Penninx, B. W., Nicklas, B. J., Simonsick, E. M., Newman, A. B., Tylavsky, F. A., Brach, J. S., Satterfield, S., Bauer, D. C., Visser, M., Rubin, S. M., Harris, T. B., eta Pahor, M. (2005). Prognostic value of usual gait speed in well-functioning older people--results from the Health, Aging and Body Composition Study. Journal of the American Geriatrics Society, 53(10), 1675–1680. https://doi.org/10.1111/j.1532-5415.2005.53501.x

Cesari, M., Landi, F., Vellas, B., Bernabei, R., eta Marzetti, E. (2014). Sarcopenia and physical frailty: two sides of the same coin. Frontiers in aging neuroscience, 6, 192. https://doi.org/10.3389/fnagi.2014.00192

Chang, J. S., Kim, T. H., Nguyen, T. T., Park, K. S., Kim, N., eta Kong, I. D. (2017). Circulating irisin levels as a predictive biomarker for sarcopenia: A cross-sectional community-based study. Geriatrics & gerontology international, 17(11), 2266–2273. https://doi.org/10.1111/ggi.13030

Charlson, M. E., Pompei, P., Ales, K. L., eta MacKenzie, C. R. (1987). A new method of classifying prognostic comorbidity in longitudinal studies: development and validation. Journal of chronic diseases, 40(5), 373–383. https://doi.org/10.1016/0021-9681(87)90171-8

Charlson, M., Szatrowski, T. P., Peterson, J., eta Gold, J. (1994). Validation of a combined comorbidity index. Journal of clinical epidemiology, 47(11), 1245–1251. https://doi.org/10.1016/0895-4356(94)90129-5

Chen Y. M. (2010). Perceived barriers to physical activity among older adults residing in long-term care institutions. Journal of clinical nursing, 19(3-4), 432–439. https://doi.org/10.1111/j.1365-2702.2009.02990.x

Chen, C. C., Wang, C., eta Huang, G. H. (2008). Functional trajectory 6 months posthospitalization: a cohort study of older hospitalized patients in Taiwan. Nursing research, 57(2), 93–100. https://doi.org/10.1097/01.NNR.0000313485.18670.e2

Chodzko-Zajko, W. J. (2014). Exercise and physical activity for older adults. Kinesiology Review, 3(1), 101-106.

Chumlea, W. C., Roche, A. F., eta Steinbaugh, M. L. (1985). Estimating stature from knee height for persons 60 to 90 years of age. Journal of the American Geriatrics Society, 33(2), 116–120. https://doi.org/10.1111/j.1532-5415.1985.tb02276.x

Cichocki, M., Quehenberger, V., Zeiler, M., Adamcik, T., Manousek, M., Stamm, T., eta Krajic, K. (2015). Effectiveness of a low-threshold physical activity intervention in residential aged care–results of a randomized controlled trial. Clinical interventions in aging, 10, 885-895 https://doi.org/10.2147/CIA.S79360

Crimmins, E. M., eta Beltrán-Sánchez, H. (2011). Mortality and morbidity trends: is there compression of morbidity?. The journals of gerontology. Series B, Psychological sciences and social sciences, 66(1), 75–86. https://doi.org/10.1093/geronb/gbq088

Cruz-Jentoft, A. J., Baeyens, J. P., Bauer, J. M., Boirie, Y., Cederholm, T., Landi, F., Martin, F. C., Michel, J. P., Rolland, Y., Schneider, S. M., Topinková, E., Vandewoude, M., Zamboni, M., eta European Working Group on Sarcopenia in Older People (2010). Sarcopenia: European consensus on definition and diagnosis: Report of the European Working Group on Sarcopenia in Older People. Age and ageing, 39(4), 412–423. https://doi.org/10.1093/ageing/afq034

Cruz-Jentoft, A. J., Bahat, G., Bauer, J., Boirie, Y., Bruyère, O., Cederholm, T., Cooper, C., Landi, F., Rolland, Y., Sayer, A. A., Schneider, S. M., Sieber, C. C., Topinkova, E., Vandewoude, M., Visser, M., Zamboni, M., eta Writing Group for the European Working Group on Sarcopenia in Older People 2 (EWGSOP2), and the Extended Group for EWGSOP2 (2019). Sarcopenia: revised European consensus on definition and diagnosis. Age and ageing, 48(1), 16–31. https://doi.org/10.1093/ageing/afy169

Cruz-Jentoft, A. J., Kiesswetter, E., Drey, M., eta Sieber, C. C. (2017). Nutrition, frailty, and sarcopenia. Aging clinical and experimental research, 29(1), 43–48. https://doi.org/10.1007/s40520-016-0709-0

De Biasio, J. C., Mittel, A. M., Mueller, A. L., Ferrante, L. E., Kim, D. H., eta Shaefi, S. (2020). Frailty in Critical Care Medicine: A Review. Anesthesia and analgesia, 130(6), 1462–1473. https://doi.org/10.1213/ANE.0000000000004665

Deer, R. R., Dickinson, J. M., Fisher, S. R., Ju, H., eta Volpi, E. (2016). Identifying effective and feasible interventions to accelerate functional recovery from hospitalization in older adults: A randomized controlled pilot trial. Contemporary clinical trials, 49, 6-14. https://doi.org/10.1016/j.cct.2016.05.001

Deer, R. R., Dickinson, J. M., Baillargeon, J., Fisher, S. R., Raji, M., & Volpi, E. (2019). A Phase I Randomized Clinical Trial of Evidence-Based, Pragmatic Interventions to Improve Functional Recovery After Hospitalization in Geriatric Patients. The journals of gerontology. Series A, Biological sciences and medical sciences, 74(10), 1628–1636. https://doi.org/10.1093/gerona/glz084

Deer, R. R., Goodlett, S. M., Fisher, S. R., Baillargeon, J., Dickinson, J. M., Raji, M., eta Volpi, E. (2018). A Randomized Controlled Pilot Trial of Interventions to Improve Functional Recovery After Hospitalization in Older Adults: Feasibility and Adherence. The journals of gerontology. Series A, Biological sciences and medical sciences, 73(2), 187–193. https://doi.org/10.1093/gerona/glx111

Dent, E., Kowal, P., eta Hoogendijk, E. O. (2016). Frailty measurement in research and clinical practice: A review. European journal of internal medicine, 31, 3–10. https://doi.org/10.1016/j.ejim.2016.03.007

Dent, E., Hoogendijk, E. O., Visvanathan, R., eta Wright, O. (2019). Malnutrition Screening and Assessment in Hospitalised Older People: a Review. The journal of nutrition, health & aging, 23(5), 431–441. https://doi.org/10.1007/s12603-019-1176-z

de Souto Barreto, P., Morley, J. E., Chodzko-Zajko, W., H Pitkala, K., Weening-Djiksterhuis, E., Rodriguez-Mañas, L., Barbagallo, M., Rosendahl, E., Sinclair, A., Landi, F., Izquierdo, M., Vellas, B., Rolland, Y., eta International Association of Gerontology and Geriatrics – Global Aging Research Network (IAGG-GARN) and the IAGG European Region Clinical Section (2016). Recommendations on Physical Activity and Exercise for Older Adults Living in Long-Term Care Facilities: A Taskforce Report. Journal of the American Medical Directors Association, 17(5), 381–392. https://doi.org/10.1016/j.jamda.2016.01.021

De la Iglesia Martínez, J., Dueñas Herrero, R., Onís Vilches, M. C., Aguado Taberné, C., Albert Colomer, C., eta Luque Luque, R. (2001). Adaptación y validación al castellano del cuestionario de Pfeiffer (SPMSQ) para detectar la existencia de deterioro cognitivo en personas mayores de 65 años [Spanish language adaptation and validation of the Pfeiffer's questionnaire (SPMSQ) to detect cognitive deterioration in people over 65

years of age]. Medicina clinica, 117(4), 129–134. https://doi.org/10.1016/s0025-7753(01)72040-4

Del Pozo-Cruz, J., Magaña, M., Ballesteros, M., Porras, M., Rodríguez Bíes, E., Navas, P., eta López-Lluch, G.. (2013). Influence of functional capacity on lipid profile, muscle damage and biochemical profile among community-dwelling elderly-people. Revista Andaluza de Medicina del Deporte, 6(2), 57-65. Retrieved from: http://scielo.isciii.es/scielo.php?script=sci_arttext&pid=S1888-75462013000200003&lng=es&tlng=es.

Deutz, N., Ashurst, I., Ballesteros, M. D., Bear, D. E., Cruz-Jentoft, A. J., Genton, L., Landi, F., Laviano, A., Norman, K., eta Prado, C. M. (2019). The Underappreciated Role of Low Muscle Mass in the Management of Malnutrition. Journal of the American Medical Directors Association, 20(1), 22–27. https://doi.org/10.1016/j.jamda.2018.11.021

DeVito, C. A., Morgan, R. O., Duque, M., Abdel-Moty, E., eta Virnig, B. A. (2003). Physical performance effects of low-intensity exercise among clinically defined high-risk elders. Gerontology, 49(3), 146–154. https://doi.org/10.1159/000069168

Diez-Ruiz, A., Bueno-Errandonea, A., Nuñez-Barrio, J., Sanchez-Martín, I., Vrotsou, K., eta Vergara, I. (2016). Factors associated with frailty in primary care: a prospective cohort study. BMC geriatrics, 16, 91. https://doi.org/10.1186/s12877-016-0263-9

Echeverria, I., Amasene, M., Urquiza, M., Labayen, I., Anaut, P., Rodriguez-Larrad, A., Irazusta, J., eta Besga, A. (2020). Multicomponent Physical Exercise in Older Adults after Hospitalization: A Randomized Controlled Trial Comparing Short- vs. Long-Term Group-Based Interventions. International journal of environmental research and public health, 17(2), 666. https://doi.org/10.3390/ijerph17020666

Elia, M., eta Stratton, R. (2004). On the ESPEN guidelines for nutritional screening 2002. Clinical nutrition (Edinburgh, Scotland), 23(1), 131–132. https://doi.org/10.1016/j.clnu.2003.09.016

Escriche-Escuder, A., Fuentes-Abolafio, I. J., Roldán-Jiménez, C., eta Cuesta-Vargas, A. I. (2021). Effects of exercise on muscle mass, strength, and physical performance in older adults with sarcopenia: A systematic review and meta-analysis according to the EWGSOP criteria. Experimental gerontology, 111420. Advance online publication. https://doi.org/10.1016/j.exger.2021.111420

Ethgen, O., Beaudart, C., Buckinx, F., Bruyère, O., eta Reginster, J. Y. (2017). The future prevalence of sarcopenia in Europe: a claim for public health action. Calcified tissue international, 100(3), 229-234. https://doi.org/10.1007/s00223-016-0220-9

Eustat. (2014). Osasunaren Panorama 2014. Retrieved from: https://eu.eustat.eus/elementos/ele0012300/Osasunaren_panorama_2014_35MB/inf0012374_e.pdf

Eustat. (2018). Euskal AEko emakumeen bizi-itxaropena (86,2 urte) altuena da 28-EB osoan. Retrieved from: https://eu.eustat.eus/elementos/ele0015400/Euskal_AEko_emakumeen_bizi-itxaropena_862_urte_altuena_da_28-EB_osoan/not0015471_e.html

Eustat. (2018b). Piramide interaktiboak. Retrieved from: https://eu.eustat.eus/indic/indicadoresgraficosvistapir.aspx?idgraf=522

Eustat. (2018d). Euskal AEk 2061ean 28.800 biztanle gehiago eduki litzake. Retrieved from: https://eu.eustat.eus/elementos/Euskal_AEk_2061ean_28800_biztanle_gehiago_eduki_litzake/not0015236_e.html

Eustat. (2019). Euskal AEko jaiotza-tasa EB-28ko batez bestekoaren oso azpitik dago. Retrieved from: https://eu.eustat.eus/elementos/ele0016600/Euskal_AEko_jaiotza-tasa_EB-28ko_batez_bestekoaren_oso_azpitik_dago/not0016676_e.html

Eustat. (2020). Euskal AEko gizonen eta emakumeen bizi-itxaropenak gora egiten jarraitzen du 2018an. Retrieved from: https://eu.eustat.eus/elementos/Euskal_AEko_gizonen_eta_emakumeen_bizi-itxaropenak_gora_egiten_jarraitzen_du_2018an/not0017229_e.html

Farlie, M. K., Robins, L., Keating, J. L., Molloy, E., eta Haines, T. P. (2013). Intensity of challenge to the balance system is not reported in the prescription of balance exercises in randomised trials: a systematic review. Journal of physiotherapy, 59(4), 227-235. https://doi.org/10.1016/S1836-9553(13)70199-1

Ferguson, K., Bradley, J. M., McAuley, D. F., Blackwood, B., eta O'Neill, B. (2019). Patients' Perceptions of an Exercise Program Delivered Following Discharge From Hospital After Critical Illness (the Revive Trial). Journal of intensive care medicine, 34(11-12), 978–984. https://doi.org/10.1177/0885066617724738

Fielding, R. A., Vellas, B., Evans, W. J., Bhasin, S., Morley, J. E., Newman, A. B., Abellan van Kan, G., Andrieu, S., Bauer, J., Breuille, D., Cederholm, T., Chandler, J., De Meynard, C., Donini, L., Harris, T., Kannt, A., Keime Guibert, F., Onder, G., Papanicolaou, D., Rolland, Y., … Zamboni, M. (2011). Sarcopenia: an undiagnosed condition in older adults. Current consensus definition: prevalence, etiology, and consequences. International working group on sarcopenia. Journal of the American Medical Directors Association, 12(4), 249–256. https://doi.org/10.1016/j.jamda.2011.01.003

Fife, E., Kostka, J., Kroc, Ł., Guligowska, A., Pigłowska, M., Sołtysik, B., Kaufman-Szymczyk, A., Fabianowska-Majewska, K., eta Kostka, T. (2018). Relationship of muscle function to circulating myostatin, follistatin and GDF11 in older women and men. BMC geriatrics, 18(1), 200. https://doi.org/10.1186/s12877-018-0888-y

Folstein, M. F., Folstein, S. E., eta McHugh, P. R. (1975). “Mini-mental state”: A practical method for grading the cognitive state of patients for the clinician. Journal of psychiatric research, 12(3), 189-198. https://doi.org/10.1016/0022-3956(75)90026-6

Franco, M. R., Tong, A., Howard, K., Sherrington, C., Ferreira, P. H., Pinto, R. Z., eta Ferreira, M. L. (2015). Older people's perspectives on participation in physical activity: a systematic review and thematic synthesis of qualitative literature. British journal of sports medicine, 49(19), 1268–1276. https://doi.org/10.1136/bjsports-2014-094015

Freedson, P. S., Melanson, E., eta Sirard, J. (1998). Calibration of the Computer Science and Applications, Inc. accelerometer. Medicine and science in sports and exercise, 30(5), 777–781. https://doi.org/10.1097/00005768-199805000-00021

Fried, L. P., Ferrucci, L., Darer, J., Williamson, J. D., eta Anderson, G. (2004). Untangling the concepts of disability, frailty, and comorbidity: implications for improved targeting and care. The journals of gerontology. Series A, Biological sciences and medical sciences, 59 (3), M255-M263. https://doi.org/10.1093/gerona/59.3.m255

Fried, L. P., Tangen, C. M., Walston, J., Newman, A. B., Hirsch, C., Gottdiener, J., Seeman, T., Tracy, R., Kop, W. J., Burke, G., McBurnie, M. A., eta Cardiovascular Health Study Collaborative Research Group (2001). Frailty in older adults: evidence for a phenotype. The journals of gerontology. Series A, Biological sciences and medical sciences, 56(3), M146–M156. https://doi.org/10.1093/gerona/56.3.m146

Garber, C. E., Blissmer, B., Deschenes, M. R., Franklin, B. A., Lamonte, M. J., Lee, I. M., Nieman, D. C., Swain, D. P., eta American College of Sports Medicine (2011). American College of Sports Medicine position stand. Quantity and quality of exercise for developing and maintaining cardiorespiratory, musculoskeletal, and neuromotor fitness in apparently healthy adults: guidance for prescribing exercise. Medicine and science in sports and exercise, 43(7), 1334–1359. https://doi.org/10.1249/MSS.0b013e318213fefb

Garcia-Garcia, F. J., Gutierrez Avila, G., Alfaro-Acha, A., Amor Andres, M. S., De Los Angeles De La Torre Lanza, M., Escribano Aparicio, M. V., Humanes Aparicio, S., Larrion Zugasti, J. L., Gomez-Serranillo Reus, M., Rodriguez-Artalejo, F., Rodriguez-Manas, L., eta Toledo Study Group (2011). The prevalence of frailty syndrome in an older population from Spain. The Toledo Study for Healthy Aging. The journal of nutrition, health & aging, 15(10), 852–856. https://doi.org/10.1007/s12603-011-0075-8

Gill, T. M., Allore, H. G., Gahbauer, E. A., eta Murphy, T. E. (2010). Change in disability after hospitalization or restricted activity in older persons. JAMA, 304(17), 1919–1928. https://doi.org/10.1001/jama.2010.1568

Gill, T. M., Gahbauer, E. A., Han, L., eta Allore, H. G. (2011). The relationship between intervening hospitalizations and transitions between frailty states. The journals of gerontology. Series A, Biological sciences and medical sciences, 66(11), 1238–1243. https://doi.org/10.1093/gerona/glr142

Goodpaster, B. H., Park, S. W., Harris, T. B., Kritchevsky, S. B., Nevitt, M., Schwartz, A. V., ... eta Newman, A. B. (2006). The loss of skeletal muscle strength, mass, and quality in older adults: the health, aging and body composition study. The Journals of Gerontology Series A: Biological Sciences and Medical Sciences, 61(10), 1059-1064. https://doi.org/10.1093/gerona/61.10.1059

Graf C. (2006). Functional decline in hospitalized older adults. The American journal of nursing, 106(1), 58–68. https://doi.org/10.1097/00000446-200601000-00032

Greysen, S. R., Stijacic Cenzer, I., Boscardin, W. J., eta Covinsky, K. E. (2017). Functional impairment: An unmeasured marker of medicare costs for postacute care of older adults. Journal of the American Geriatrics Society, 65(9), 1996-2002. https://doi.org/10.1111/jgs.14955

Guerin, M., Mackintosh, S., eta Fryer, C. (2008). Exercise class participation among residents in low-level residential aged care could be enhanced: a qualitative study. The Australian journal of physiotherapy, 54(2), 111–117. https://doi.org/10.1016/s0004-9514(08)70044-8

Guglielmi, G., Ponti, F., Agostini, M., Amadori, M., Battista, G., eta Bazzocchi, A. (2016). The role of DXA in sarcopenia. Aging clinical and experimental research, 28(6), 1047-1060. https://doi.org/10.1007/s40520-016-0589-3

Guigoz, Y., Lauque, S., eta Vellas, B. J. (2002). Identifying the elderly at risk for malnutrition. The Mini Nutritional Assessment. Clinics in geriatric medicine, 18(4), 737–757. https://doi.org/10.1016/s0749-0690(02)00059-9

Guigoz, Y., Vellas, B., eta Garry, P. J. (1996). Assessing the nutritional status of the elderly: The Mini Nutritional Assessment as part of the geriatric evaluation. Nutrition reviews, 54(1 Pt 2), S59–S65. https://doi.org/10.1111/j.1753-4887.1996.tb03793.x

Guralnik, J. M., Ferrucci, L., Pieper, C. F., Leveille, S. G., Markides, K. S., Ostir, G. V., Studenski, S., Berkman, L. F., eta Wallace, R. B. (2000). Lower extremity function and subsequent disability: consistency across studies, predictive models, and value of gait speed alone compared with the short physical performance battery. The journals of gerontology. Series A, Biological sciences and medical sciences, 55(4), M221–M231. https://doi.org/10.1093/gerona/55.4.m221

Han, C. Y., Miller, M., Yaxley, A., Baldwin, C., Woodman, R., eta Sharma, Y. (2020). Effectiveness of combined exercise and nutrition interventions in prefrail or frail older hospitalised patients: a systematic review and meta-analysis. BMJ open, 10(12), e040146. https://doi.org/10.1136/bmjopen-2020-040146

Harada, C. N., Love, M. C. N., eta Triebel, K. L. (2013). Normal cognitive aging. Clinics in geriatric medicine, 29(4), 737-752. https://doi.org/10.1016/j.cger.2013.07.002

Hart, T. L., Swartz, A. M., Cashin, S. E., eta Strath, S. J. (2011). How many days of monitoring predict physical activity and sedentary behaviour in older adults?. The international

journal of behavioral nutrition and physical activity, 8, 62. https://doi.org/10.1186/1479-5868-8-62

Hill, A. M., Hoffmann, T., McPhail, S., Beer, C., Hill, K. D., Brauer, S. G., eta Haines, T. P. (2011). Factors associated with older patients' engagement in exercise after hospital discharge. Archives of physical medicine and rehabilitation, 92(9), 1395–1403. https://doi.org/10.1016/j.apmr.2011.04.009

Hill, K. D., Hunter, S. W., Batchelor, F. A., Cavalheri, V., eta Burton, E. (2015). Individualized home-based exercise programs for older people to reduce falls and improve physical performance: A systematic review and meta-analysis. Maturitas, 82(1), 72–84. https://doi.org/10.1016/j.maturitas.2015.04.005

Hu, X., Zhang, L., Wang, H., Hao, Q., Dong, B., eta Yang, M. (2017). Malnutrition-sarcopenia syndrome predicts mortality in hospitalized older patients. Scientific reports, 7(1), 1-9.

Hung, Y., Wijnhoven, H. A., Visser, M., eta Verbeke, W. (2019). Appetite and protein intake strata of older adults in the European union: Socio-demographic and health characteristics, diet-related and physical activity behaviours. Nutrients, 11(4), 777. https://doi.org/10.3390/nu11040777

Ibrahim, K., Howson, F., Culliford, D. J., Sayer, A. A., eta Roberts, H. C. (2019). The feasibility of assessing frailty and sarcopenia in hospitalised older people: a comparison of commonly used tools. BMC geriatrics, 19(1), 42. https://doi.org/10.1186/s12877-019-1053-y

INE: Instituto Nacional de Estadística. (2019). Proporción de personas mayores de cierta edad por provincia. Retrieved from: https://www.ine.es/jaxiT3/Tabla.htm?t=1488

INE: Instituto Nacional de Estadística. (2020). Población de España: ayer, hoy y mañana. Retrieved from: https://ine.es/infografias/infografia_dia_poblacion.pdf

Izquierdo, M.; Casas-Herrero, A.; Zambom-Ferraresi, F.; Martínez-Velilla, N.; Alonso-Bouzón, C.; Rodríguez-Mañas, L. (2017). Multi-Component Physical Exercise Program VIVIFRAIL. Retrieved from:

http://www.vivifrail.com/images/recursos/EN-P.SANITARIOS-portadas-web.pdf

Kaiser, M. J., Bauer, J. M., Ramsch, C., Uter, W., Guigoz, Y., Cederholm, T., Thomas, D. R., Anthony, P., Charlton, K. E., Maggio, M., Tsai, A. C., Grathwohl, D., Vellas, B., Sieber, C. C., eta MNA-International Group (2009). Validation of the Mini Nutritional Assessment short-form (MNA-SF): a practical tool for identification of nutritional status. The journal of nutrition, health & aging, 13(9), 782–788. https://doi.org/10.1007/s12603-009-0214-7

Kanach, F. A., Pastva, A. M., Hall, K. S., Pavon, J. M., eta Morey, M. C. (2018). Effects of structured exercise interventions for older adults hospitalized with acute medical

illness: a systematic review. Journal of aging and physical activity, 26(2), 284-303. https://doi.org/10.1123/japa.2016-0372

Keeler, E., Guralnik, J. M., Tian, H., Wallace, R. B., eta Reuben, D. B. (2010). The impact of functional status on life expectancy in older persons. Journals of gerontology series a: biomedical sciences and medical sciences, 65(7), 727-733. https://doi.org/10.1093/gerona/glq029

Kirkwood T. (2017). Why and how are we living longer?. Experimental physiology, 102(9), 1067–1074. https://doi.org/10.1113/EP086205

Kollia, N., Caballero, F. F., Sánchez-Niubó, A., Tyrovolas, S., Ayuso-Mateos, J. L., Haro, J. M., Chatterji, S., eta Panagiotakos, D. B. (2018). Social determinants, health status and 10-year mortality among 10,906 older adults from the English longitudinal study of aging: the ATHLOS project. BMC public health, 18(1), 1357. https://doi.org/10.1186/s12889-018-6288-6

Kosse, N. M., Dutmer, A. L., Dasenbrock, L., Bauer, J. M., eta Lamoth, C. J. (2013). Effectiveness and feasibility of early physical rehabilitation programs for geriatric hospitalized patients: a systematic review. BMC geriatrics, 13, 107. https://doi.org/10.1186/1471-2318-13-107.

Kress, J. P., eta Herridge, M. S. (2012). Medical and economic implications of physical disability of survivorship. Seminars in respiratory and critical care medicine, 33(4), 339-347.

Krumholz H. M. (2013). Post-hospital syndrome--an acquired, transient condition of generalized risk. The New England journal of medicine, 368(2), 100–102. https://doi.org/10.1056/NEJMp1212324

Kwak, J. Y., Hwang, H., Kim, S. K., Choi, J. Y., Lee, S. M., Bang, H., Kwon, E. S., Lee, K. P., Chung, S. G., eta Kwon, K. S. (2018). Prediction of sarcopenia using a combination of multiple serum biomarkers. Scientific reports, 8(1), 8574. https://doi.org/10.1038/s41598-018-26617-9

Lacroix, A., Hortobágyi, T., Beurskens, R., eta Granacher, U. (2017). Effects of Supervised vs. Unsupervised Training Programs on Balance and Muscle Strength in Older Adults: A Systematic Review and Meta-Analysis. Sports medicine (Auckland, N.Z.), 47(11), 2341–2361. https://doi.org/10.1007/s40279-017-0747-6

Lacroix, A., Kressig, R. W., Muehlbauer, T., Gschwind, Y. J., Pfenninger, B., Bruegger, O., eta Granacher, U. (2016). Effects of a Supervised versus an Unsupervised Combined Balance and Strength Training Program on Balance and Muscle Power in Healthy Older Adults: A Randomized Controlled Trial. Gerontology, 62(3), 275–288. https://doi.org/10.1159/000442087

Langlois, F., Vu, T. T. M., Kergoat, M. J., Chassé, K., Dupuis, G., eta Bherer, L. (2012). The multiple dimensions of frailty: physical capacity, cognition, and quality of life.

International psychogeriatrics, 24(9), 1429-1436. https://doi.org/10.1017/S1041610212000634

Lawton, M. P., eta Brody, E. M. (1969). Assessment of Older People: Self-Maintaining and Instrumental Activities of Daily Living. The Gerontologist, 9(3), 179–86.

Lee, K., Shin, Y., Huh, J., Sung, Y. S., Lee, I. S., Yoon, K. H., eta Kim, K. W. (2019). Recent Issues on Body Composition Imaging for Sarcopenia Evaluation. Korean journal of radiology, 20(2), 205–217. https://doi.org/10.3348/kjr.2018.0479

Lee, L., Patel, T., Costa, A., Bryce, E., Hillier, L. M., Slonim, K., Hunter, S. W., Heckman, G., eta Molnar, F. (2017). Screening for frailty in primary care: accuracy of gait speed and hand-grip strength. Canadian family physician Medecin de famille canadien, 63(1), e51-e57.

Leenders, M., Verdijk, L. B., van der Hoeven, L., van Kranenburg, J., Nilwik, R., eta van Loon, L. J. (2013).Elderly men and women benefit equally from prolonged resistance-type exercise training. The journals of gerontology. Series A, Biological sciences and medical sciences, 68(7), 769–779. https://doi.org/10.1093/gerona/gls241

Lee, S. J., Lee, Y. S., Zimmers, T. A., Soleimani, A., Matzuk, M. M., Tsuchida, K., Cohn, R. D., eta Barton, E. R. (2010). Regulation of muscle mass by follistatin and activins. Molecular endocrinology (Baltimore, Md.), 24(10), 1998–2008. https://doi.org/10.1210/me.2010-0127

Leong, D. P., Teo, K. K., Rangarajan, S., Lopez-Jaramillo, P., Avezum, A., Jr, Orlandini, A., Seron, P., Ahmed, S. H., Rosengren, A., Kelishadi, R., Rahman, O., Swaminathan, S., Iqbal, R., Gupta, R., Lear, S. A., Oguz, A., Yusoff, K., Zatonska, K., Chifamba, J., Igumbor, E., … Prospective Urban Rural Epidemiology (PURE) Study investigators (2015). Prognostic value of grip strength: findings from the Prospective Urban Rural Epidemiology (PURE) study. Lancet (London, England), 386(9990), 266–273. https://doi.org/10.1016/S0140-6736(14)62000-6

Liaw, F. Y., Kao, T. W., Fang, W. H., Han, D. S., Chi, Y. C., eta Yang, W. S. (2016). Increased follistatin associated with decreased gait speed among old adults. European journal of clinical investigation, 46(4), 321–327. https://doi.org/10.1111/eci.12595

Ligthart-Melis, G. C., Luiking, Y. C., Kakourou, A., Cederholm, T., Maier, A. B., eta de van der Schueren, M. (2020). Frailty, Sarcopenia, and Malnutrition Frequently (Co-)occur in Hospitalized Older Adults: A Systematic Review and Meta-analysis. Journal of the American Medical Directors Association, 21(9), 1216–1228. https://doi.org/10.1016/j.jamda.2020.03.006

Liu, C. J., & Latham, N. K. (2009). Progressive resistance strength training for improving physical function in older adults. The Cochrane database of systematic reviews, 2009(3), CD002759. https://doi.org/10.1002/14651858.CD002759.pub2

Lozano-Montoya, I., Correa-Pérez, A., Abraha, I., Soiza, R. L., Cherubini, A., O'Mahony, D., eta Cruz-Jentoft, A. J. (2017). Nonpharmacological interventions to treat physical frailty and sarcopenia in older patients: a systematic overview - the SENATOR Project ONTOP Series. Clinical interventions in aging, 12, 721–740. https://doi.org/10.2147/CIA.S132496

Cunha, A. I. L., Veronese, N., de Melo Borges, S., eta Ricci, N. A. (2019). Frailty as a predictor of adverse outcomes in hospitalized older adults: a systematic review and meta-analysis. Ageing research reviews, 56, 100960. https://doi.org/10.1016/j.arr.2019.100960

Mafi, F., Biglari, S., Ghardashi Afousi, A., eta Gaeini, A. A. (2019). Improvement in Skeletal Muscle Strength and Plasma Levels of Follistatin and Myostatin Induced by an 8-Week Resistance Training and Epicatechin Supplementation in Sarcopenic Older Adults. Journal of aging and physical activity, 27(3), 384–391. https://doi.org/10.1123/japa.2017-0389

Mahoney, F. I., eta Barthel, D. W. (1965). Functional evaluation: the Barthel Index: a simple index of independence useful in scoring improvement in the rehabilitation of the chronically ill. Maryland state medical journal.

Makizako, H., Nakai, Y., Tomioka, K., Taniguchi, Y., Sato, N., Wada, A., Kiyama, R., Tsutsumimoto, K., Ohishi, M., Kiuchi, Y., Kubozono, T., eta Takenaka, T. (2020). Effects of a Multicomponent Exercise Program in Physical Function and Muscle Mass in Sarcopenic/Pre-Sarcopenic Adults. Journal of clinical medicine, 9(5), 1386. https://doi.org/10.3390/jcm9051386

Marfell-Jones, M. J., Stewart, A. D., eta de Ridder, J. H. (2012). International standards for anthropometric assessment. Wellington, New Zealand: International society for the advancement of kinanthropometry.

Mariot, V., Joubert, R., Hourdé, C., Féasson, L., Hanna, M., Muntoni, F., Maisonobe, T., Servais, L., Bogni, C., Le Panse, R., Benvensite, O., Stojkovic, T., Machado, P. M., Voit, T., Buj-Bello, A., eta Dumonceaux, J. (2017). Downregulation of myostatin pathway in neuromuscular diseases may explain challenges of anti-myostatin therapeutic approaches. Nature communications, 8(1), 1859. https://doi.org/10.1038/s41467-017-01486-4

Martínez-Velilla, N., Casas-Herrero, A., Zambom-Ferraresi, F., Sáez de Asteasu, M. L., Lucia, A., Galbete, A., García-Baztán, A., Alonso-Renedo, J., González-Glaría, B., Gonzalo-Lázaro, M., Apezteguía Iráizoz, I., Gutiérrez-Valencia, M., Rodríguez-Mañas, L., eta Izquierdo, M. (2019). Effect of Exercise Intervention on Functional Decline in Very Elderly Patients During Acute Hospitalization: A Randomized Clinical Trial. JAMA internal medicine, 179(1), 28–36. https://doi.org/10.1001/jamainternmed.2018.4869

Mather, M. (2016). The affective neuroscience of aging. Annual Review of Phychology, 67, 213-238. https://doi.org/10.1146/annurev-psych-122414-033540

Mathews, S. B., Arnold, S. E., eta Epperson, C. N. (2014). Hospitalization and cognitive decline: Can the nature of the relationship be deciphered?. The American journal of geriatric psychiatry : official journal of the American Association for Geriatric Psychiatry, 22(5), 465–480. https://doi.org/10.1016/j.jagp.2012.08.012

Merchant, R. A., Morley, J. E., eta Izquierdo, M. (2021). Editorial: Exercise, Aging and Frailty: Guidelines for Increasing Function. The journal of nutrition, health & aging, 25(4), 405–409. https://doi.org/10.1007/s12603-021-1590-x

Migueles, J. H., Cadenas-Sanchez, C., Ekelund, U., Delisle Nyström, C., Mora-Gonzalez, J., Löf, M., Labayen, I., Ruiz, J. R., eta Ortega, F. B. (2017). Accelerometer Data Collection and Processing Criteria to Assess Physical Activity and Other Outcomes: A Systematic Review and Practical Considerations. Sports medicine (Auckland, N.Z.), 47(9), 1821–1845. https://doi.org/10.1007/s40279-017-0716-0

Milanović, Z., Pantelić, S., Trajković, N., Sporiš, G., Kostić, R., eta James, N. (2013). Age-related decrease in physical activity and functional fitness among elderly men and women. Clinical interventions in aging, 8, 549-556. https://doi.org/10.2147/CIA.S44112

Miljkovic, N., Lim, J. Y., Miljkovic, I., eta Frontera, W. R. (2015). Aging of skeletal muscle fibers. Annals of rehabilitation medicine, 39(2), 155-162. https://doi.org/10.5535/arm.2015.39.2.155

Mitchell, W. K., Atherton, P. J., Williams, J., Larvin, M., Lund, J. N., eta Narici, M. (2012). Sarcopenia, dynapenia, and the impact of advancing age on human skeletal muscle size and strength; a quantitative review. Frontiers in physiology, 3, 260. https://doi.org/10.3389/fphys.2012.00260

Montero-Fernandez, N., eta Serra-Rexach, J. A. (2013). Role of exercise on sarcopenia in the elderly. European journal of physical and rehabilitation medicine, 49(1), 131-143.

Montero-Odasso, M., Schapira, M., Varela, C., Pitteri, C., Soriano, E. R., Kaplan, R., Camera, L. A., eta Mayorga, L. M. (2004). Gait velocity in senior people. An easy test for detecting mobility impairment in community elderly. The journal of nutrition, health & aging, 8(5), 340–343.

Morley, J. E., von Haehling, S., Anker, S. D., eta Vellas, B. (2014). From sarcopenia to frailty: a road less traveled. Journal of cachexia, sarcopenia and muscle, 5(1), 5–8. https://doi.org/10.1007/s13539-014-0132-3

Morley, J. E., Vellas, B., van Kan, G. A., Anker, S. D., Bauer, J. M., Bernabei, R., Cesari, M., Chumlea, W. C., Doehner, W., Evans, J., Fried, L. P., Guralnik, J. M., Katz, P. R., Malmstrom, T. K., McCarter, R. J., Gutierrez Robledo, L. M., Rockwood, K., von Haehling, S., Vandewoude, M. F., eta Walston, J. (2013). Frailty consensus: a call to action. Journal of the American Medical Directors Association, 14(6), 392–397. https://doi.org/10.1016/j.jamda.2013.03.022

Mudge, A. M., Denaro, C. P., Scott, A. C., Meyers, D., Adsett, J. A., Mullins, R. W., Suna, J. M., Atherton, J. J., Marwick, T. H., Scuffham, P., eta O'Rourke, P. (2018). Addition of Supervised Exercise Training to a Post-Hospital Disease Management Program for Patients Recently Hospitalized With Acute Heart Failure: The EJECTION-HF Randomized Phase 4 Trial. JACC. Heart failure, 6(2), 143–152. https://doi.org/10.1016/j.jchf.2017.11.016

Nascimento, C. M., Ingles, M., Salvador-Pascual, A., Cominetti, M. R., Gomez-Cabrera, M. C., eta Viña, J. (2019). Sarcopenia, frailty and their prevention by exercise. Free radical biology & medicine, 132, 42–49. https://doi.org/10.1016/j.freeradbiomed.2018.08.035

Negaresh, R., Ranjbar, R., Baker, J. S., Habibi, A., Mokhtarzade, M., Gharibvand, M. M., eta Fokin, A. (2019). Skeletal muscle hypertrophy, insulin-like growth factor 1, myostatin and follistatin in healthy and sarcopenic elderly men: the effect of whole-body resistance training. International journal of preventive medicine, 10, 29. https://doi.org/10.4103/ijpvm.IJPVM_310_17

Nelson, M. E., Rejeski, W. J., Blair, S. N., Duncan, P. W., Judge, J. O., King, A. C., Macera, C. A., Castaneda-Sceppa, C., American College of Sports Medicine, eta American Heart Association (2007). Physical activity and public health in older adults: recommendation from the American College of Sports Medicine and the American Heart Association. Circulation, 116(9), 1094–1105. https://doi.org/10.1161/CIRCULATIONAHA.107.185650

Nyberg, L., Lövdén, M., Riklund, K., Lindenberger, U., eta Bäckman, L. (2012). Memory aging and brain maintenance. Trends in Cognitive Sciences, 16(5), 292-305. https://doi.org/10.1016/j.tics.2012.04.005

O'Brien, S., Kavanagh, R. G., Carey, B. W., Maher, M. M., O'Connor, O. J., eta Andrews, E. J. (2018). The impact of sarcopenia and myosteatosis on postoperative outcomes in patients with inflammatory bowel disease. European radiology experimental, 2(1), 37. https://doi.org/10.1186/s41747-018-0072-3

Oliveira, M. R., Fogaça, K. C., eta Leandro-Merhi, V. A. (2009). Nutritional status and functional capacity of hospitalized elderly. Nutrition journal, 8, 54. https://doi.org/10.1186/1475-2891-8-54

Pahor, M., Guralnik, J. M., Ambrosius, W. T., Blair, S., Bonds, D. E., Church, T. S., Espeland, M. A., Fielding, R. A., Gill, T. M., Groessl, E. J., King, A. C., Kritchevsky, S. B., Manini, T. M., McDermott, M. M., Miller, M. E., Newman, A. B., Rejeski, W. J., Sink, K. M., Williamson, J. D., eta LIFE study investigators (2014). Effect of structured physical activity on prevention of major mobility disability in older adults: the LIFE study randomized clinical trial. JAMA, 311(23), 2387–2396. https://doi.org/10.1001/jama.2014.5616

Pamoukdjian, F., Paillaud, E., Zelek, L., Laurent, M., Lévy, V., Landre, T., eta Sebbane, G. (2015). Measurement of gait speed in older adults to identify complications associated with frailty: A systematic review. Journal of geriatric oncology, 6(6), 484–496. https://doi.org/10.1016/j.jgo.2015.08.006

Paw, M. J. C. A., van Uffelen, J. G., Riphagen, I., eta van Mechelen, W. (2008). The functional effects of physical exercise training in frail older people : a systematic review. Sports medicine (Auckland, N.Z.), 38(9), 781-793. https://doi.org/10.2165/00007256-200838090-00006

Perera, S., Mody, S. H., Woodman, R. C., eta Studenski, S. A. (2006). Meaningful change and responsiveness in common physical performance measures in older adults. Journal of the American Geriatrics Society, 54(5), 743–749. https://doi.org/10.1111/j.1532-5415.2006.00701.x

Pfeiffer E. (1975). A short portable mental status questionnaire for the assessment of organic brain deficit in elderly patients. Journal of the American Geriatrics Society, 23(10), 433–441. https://doi.org/10.1111/j.1532-5415.1975.tb00927.x

Piepoli, M. F., Corrà, U., Benzer, W., Bjarnason-Wehrens, B., Dendale, P., Gaita, D., McGee, H., Mendes, M., Niebauer, J., Zwisler, A. D., Schmid, J. P., eta Cardiac Rehabilitation Section of the European Association of Cardiovascular Prevention and Rehabilitation (2010). Secondary prevention through cardiac rehabilitation: from knowledge to implementation. A position paper from the Cardiac Rehabilitation Section of the European Association of Cardiovascular Prevention and Rehabilitation. European journal of cardiovascular prevention and rehabilitation : official journal of the European Society of Cardiology, Working Groups on Epidemiology & Prevention and Cardiac Rehabilitation and Exercise Physiology, 17(1), 1–17. https://doi.org/10.1097/HJR.0b013e3283313592

Pinheiro, P. A., Carneiro, J. A. O., Coqueiro, R. S., Pereira, R., eta Fernandes, M. H. (2016). “Chair stand test” as simple tool for sarcopenia screening in elderly women. The journal of nutrition, health & aging, 20(1), 56-59. https://doi.org/10.1007/s12603-016-0676-3

Ratkevicius, A., Joyson, A., Selmer, I., Dhanani, T., Grierson, C., Tommasi, A. M., DeVries, A., Rauchhaus, P., Crowther, D., Alesci, S., Yaworsky, P., Gilbert, F., Redpath, T. W., Brady, J., Fearon, K. C., Reid, D. M., Greig, C. A., eta Wackerhage, H. (2011). Serum concentrations of myostatin and myostatin-interacting proteins do not differ between young and sarcopenic elderly men. The Journals of Gerontology. Series A, Biological sciences and medical sciences, 66(6), 620–626. https://doi.org/10.1093/gerona/glr025

Reid, K. F., Naumova, E. N., Carabello, R. J., Phillips, E. M., eta Fielding, R. A. (2008). Lower extremity muscle mass predicts functional performance in mobility-limited elders. The

journal of nutrition health & aging, 12(7), 493-498. https://doi.org/10.1007/BF02982711

Rijk, J. M., Roos, P. R., Deckx, L., van den Akker, M., eta Buntinx, F. (2016). Prognostic value of handgrip strength in people aged 60 years and older: A systematic review and meta-analysis. Geriatrics & gerontology international, 16(1), 5–20. https://doi.org/10.1111/ggi.12508

Rikli, R.E., eta Jones, C.J. (2001). Senior Fitness Test Manual. Champaign, USA: Human Kinetics.

Robins, L. M., Brown, T., Lalor, A. F., Stolwyk, R., McDermott, F., eta Haines, T. (2018). Social Isolation, Physical Capacity, and Physical Activity in Older Community-Dwelling Adults Post-Hospitalization. Journal of aging and physical activity, 26(2), 204–213. https://doi.org/10.1123/japa.2016-0257

Rockwood, K., eta Howlett, S. E. (2018). Fifteen years of progress in understanding frailty and health in aging. BMC medicine, 16(1), 220. https://doi.org/10.1186/s12916-018-1223-3

Rodgers, B. D., eta Garikipati, D. K. (2008). Clinical, agricultural, and evolutionary biology of myostatin: a comparative review. Endocrine reviews, 29(5), 513-534. https://doi.org/10.1210/er.2008-0003

Rodriguez-Larrad, A., Arrieta, H., Rezola, C., Kortajarena, M., Yanguas, J. J., Iturburu, M., Susana, M. G., eta Irazusta, J. (2017). Effectiveness of a multicomponent exercise program in the attenuation of frailty in long-term nursing home residents: study protocol for a randomized clinical controlled trial. BMC geriatrics, 17(1), 60. https://doi.org/10.1186/s12877-017-0453-0

Rodríguez López, S., Montero, P., Carmenate, M., eta Avendano, M. (2014). Functional decline over 2 years in older Spanish adults: evidence from the Survey of Health, Ageing and Retirement in Europe. Geriatrics & gerontology international, 14(2), 403–412. https://doi.org/10.1111/ggi.12115

Rodríguez-Mañas, L., Féart, C., Mann, G., Viña, J., Chatterji, S., Chodzko-Zajko, W., Gonzalez-Colaço Harmand, M., Bergman, H., Carcaillon, L., Nicholson, C., Scuteri, A., Sinclair, A., Pelaez, M., Van der Cammen, T., Beland, F., Bickenbach, J., Delamarche, P., Ferrucci, L., Fried, L. P., Gutiérrez-Robledo, L. M., … FOD-CC group (Appendix 1) (2013). Searching for an operational definition of frailty: a Delphi method based consensus statement: the frailty operative definition-consensus conference project. The journals of gerontology. Series A, Biological sciences and medical sciences, 68(1), 62–67. https://doi.org/10.1093/gerona/gls119

Rosano, C., Newman, A. B., Katz, R., Hirsch, C. H., eta Kuller, L. H. (2008). Association between lower digit symbol substitution test score and slower gait and greater risk of mortality and of developing incident disability in well-functioning older adults. Journal

of *Journal of the American Geriatrics Society*, *56*(9), 1618–1625. https://doi.org/10.1111/j.1532-5415.2008.01856.x

Ruano-Ravina, A., Pena-Gil, C., Abu-Assi, E., Raposeiras, S., van 't Hof, A., Meindersma, E., Bossano Prescott, E. I., eta González-Juanatey, J. R. (2016). Participation and adherence to cardiac rehabilitation programs. A systematic review. International journal of cardiology, 223, 436–443. https://doi.org/10.1016/j.ijcard.2016.08.120

Ruiz, J. G., Dent, E., Morley, J. E., Merchant, R. A., Beilby, J., Beard, J., Tripathy, C., Sorin, M., Andrieu, S., Aprahamian, I., Arai, H., Aubertin-Leheudre, M., Bauer, J. M., Cesari, M., Chen, L. K., Cruz-Jentoft, A. J., De Souto Barreto, P., Dong, B., Ferrucci, L., Fielding, R., … Vellas, B. (2020). Screening for and Managing the Person with Frailty in Primary Care: ICFSR Consensus Guidelines. The journal of nutrition, health & aging, 24(9), 920–927. https://doi.org/10.1007/s12603-020-1492-3

Sáez de Asteasu, M. L., Martínez-Velilla, N., Zambom-Ferraresi, F., Casas-Herrero, Á., Cadore, E. L., Galbete, A., eta Izquierdo, M. (2019). Assessing the impact of physical exercise on cognitive function in older medical patients during acute hospitalization: Secondary analysis of a randomized trial. PLoS medicine, 16(7), e1002852. https://doi.org/10.1371/journal.pmed.1002852

Santilli, V., Bernetti, A., Mangone, M., eta Paoloni, M. (2014). Clinical definition of sarcopenia. Clinical cases in mineral and bone metabolism : the official journal of the Italian Society of Osteoporosis, Mineral Metabolism, and Skeletal Diseases, 11(3), 177–180.

Sauer, A. C., Goates, S., Malone, A., Mogensen, K. M., Gewirtz, G., Sulz, I., Moick, S., Laviano, A., eta Hiesmayr, M. (2019). Prevalence of Malnutrition Risk and the Impact of Nutrition Risk on Hospital Outcomes: Results From nutritionDay in the U.S. JPEN. Journal of parenteral and enteral nutrition, 43(7), 918–926. https://doi.org/10.1002/jpen.1499

Savva, G. M., Donoghue, O. A., Horgan, F., O'Regan, C., Cronin, H., eta Kenny, R. A. (2013). Using timed up-and-go to identify frail members of the older population. Journals of Gerontology Series A: Biomedical Sciences and Medical Sciences, 68(4), 441-446. https://doi.org/10.1093/gerona/gls190

Sayer, A. A., eta Kirkwood, T. B. (2015). Grip strength and mortality: a biomarker of ageing?. Lancet (London, England), 386(9990), 226–227. https://doi.org/10.1016/S0140-6736(14)62349-7

Scully T. (2012). Demography: To the limit. Nature, 492(7427), S2–S3. https://doi.org/10.1038/492S2a

Sherrington, C., Lord, S. R., Vogler, C. M., Close, J. C., Howard, K., Dean, C. M., Heller, G. Z., Clemson, L., O'Rourke, S. D., Ramsay, E., Barraclough, E., Herbert, R. D., eta Cumming, R. G. (2014). A post-hospital home exercise program improved mobility but increased

falls in older people: a randomised controlled trial. PloS one, 9(9), e104412. https://doi.org/10.1371/journal.pone.0104412

Siddique, N., O'Donoghue, M., Casey, M. C., eta Walsh, J. B. (2017). Malnutrition in the elderly and its effects on bone health–A review. Clinical nutrition ESPEN, 21, 31-39. https://doi.org/10.1016/j.clnesp.2017.06.001

Spruit, M. A., Singh, S. J., Garvey, C., ZuWallack, R., Nici, L., Rochester, C., Hill, K., Holland, A. E., Lareau, S. C., Man, W. D., Pitta, F., Sewell, L., Raskin, J., Bourbeau, J., Crouch, R., Franssen, F. M., Casaburi, R., Vercoulen, J. H., Vogiatzis, I., Gosselink, R., … ATS/ERS Task Force on Pulmonary Rehabilitation (2013). An official American Thoracic Society/European Respiratory Society statement: key concepts and advances in pulmonary rehabilitation. American journal of respiratory and critical care medicine, 188(8), e13–e64. https://doi.org/10.1164/rccm.201309-1634ST

Stevens-Lapsley, J. E., Loyd, B. J., Falvey, J. R., Figiel, G. J., Kittelson, A. J., Cumbler, E. U., eta Mangione, K. K. (2016). Progressive multi-component home-based physical therapy for deconditioned older adults following acute hospitalization: a pilot randomized controlled trial. Clinical rehabilitation, 30(8), 776-785. https://doi.org/10.1177/0269215515603219

Studenski, S., Perera, S., Patel, K., Rosano, C., Faulkner, K., Inzitari, M., Brach, J., Chandler, J., Cawthon, P., Connor, E. B., Nevitt, M., Visser, M., Kritchevsky, S., Badinelli, S., Harris, T., Newman, A. B., Cauley, J., Ferrucci, L., eta Guralnik, J. (2011). Gait speed and survival in older adults. JAMA, 305(1), 50–58. https://doi.org/10.1001/jama.2010.1923

Suetta, C., Magnusson, S. P., Beyer, N., eta Kjaer, M. (2007). Effect of strength training on muscle function in elderly hospitalized patients. Scandinavian journal of medicine & science in sports, 17(5), 464-472. https://doi.org/10.1111/j.1600-0838.2007.00712.x

Talar, K., Hernández-Belmonte, A., Vetrovsky, T., Steffl, M., Kałamacka, E., eta Courel-Ibáñez, J. (2021). Benefits of Resistance Training in Early and Late Stages of Frailty and Sarcopenia: A Systematic Review and Meta-Analysis of Randomized Controlled Studies. Journal of clinical medicine, 10(8), 1630. https://doi.org/10.3390/jcm10081630

The Lancet Public Health (2017). Ageing: a 21st century public health challenge?. The Lancet. Public health, 2(7), e297. https://doi.org/10.1016/S2468-2667(17)30125-1

Tieland, M., Trouwborst, I. eta Clark, B.C. (2018). Skeletal muscle performance and ageing. Journal of Cachexia, Sarcopenia and Muscle, 9(1), 3-19. https://doi.org/10.1002/jcsm.12238

Tieland, M., van de Rest, O., Dirks, M. L., van der Zwaluw, N., Mensink, M., van Loon, L. J., eta de Groot, L. C. (2012). Protein supplementation improves physical performance in frail elderly people: a randomized, double-blind, placebo-controlled trial. Journal of

the American Medical Directors Association, 13(8), 720–726. https://doi.org/10.1016/j.jamda.2012.07.005

Timmerman, K. L., Dhanani, S., Glynn, E. L., Fry, C. S., Drummond, M. J., Jennings, K., Rasmussen, B. B., eta Volpi, E. (2012). A moderate acute increase in physical activity enhances nutritive flow and the muscle protein anabolic response to mixed nutrient intake in older adults. The American journal of clinical nutrition, 95(6), 1403–1412. https://doi.org/10.3945/ajcn.111.020800

Timonen, L., Rantanen, T., Ryynänen, O. P., Taimela, S., Timonen, T. E., eta Sulkava, R. (2002). A randomized controlled trial of rehabilitation after hospitalization in frail older women: effects on strength, balance and mobility. Scandinavian journal of medicine & science in sports, 12(3), 186–192. https://doi.org/10.1034/j.1600-0838.2002.120310.x

Toots, A., Littbrand, H., Lindelöf, N., Wiklund, R., Holmberg, H., Nordström, P., Lundin-Olsson, L., Gustafson, Y., eta Rosendahl, E. (2016). Effects of a High-Intensity Functional Exercise Program on Dependence in Activities of Daily Living and Balance in Older Adults with Dementia. Journal of the American Geriatrics Society, 64(1), 55–64. https://doi.org/10.1111/jgs.13880

Troiano, R. P., Berrigan, D., Dodd, K. W., Mâsse, L. C., Tilert, T., eta McDowell, M. (2008). Physical activity in the United States measured by accelerometer. Medicine and science in sports and exercise, 40(1), 181–188. https://doi.org/10.1249/mss.0b013e31815a51b3

Tsekoura, M., Billis, E., Tsepis, E., Dimitriadis, Z., Matzaroglou, C., Tyllianakis, M., Panagiotopoulos, E., eta Gliatis, J. (2018). The Effects of Group and Home-Based Exercise Programs in Elderly with Sarcopenia: A Randomized Controlled Trial. Journal of clinical medicine, 7(12), 480. https://doi.org/10.3390/jcm7120480.

Van Ancum, J. M., Scheerman, K., Jonkman, N. H., Smeenk, H. E., Kruizinga, R. C., Meskers, C. G., eta Maier, A. B. (2017). Change in muscle strength and muscle mass in older hospitalized patients: a systematic review and meta-analysis. Experimental gerontology, 92, 34-41. https://doi.org/10.1016/j.exger.2017.03.006

van der Deijl, M., Etman, A., Kamphuis, C. B., eta van Lenthe, F. J. (2014). Participation levels of physical activity programs for community-dwelling older adults: a systematic review. BMC public health, 14, 1301. https://doi.org/10.1186/1471-2458-14-1301

Vellas, B. (2016). White book on frailty. Retrieved from: https://www.jpn-geriat-soc.or.jp/gakujutsu/pdf/whitebook

Visvanathan, R. (2015). Anorexia of aging. Clinics in geriatric medicine, 31(3), 417-427. https://doi.org/10.1016/j.cger.2015.04.012

Vogler, C. M., Sherrington, C., Ogle, S. J., eta Lord, S. R. (2009). Reducing risk of falling in older people discharged from hospital: a randomized controlled trial comparing

seated exercises, weight-bearing exercises, and social visits. Archives of physical medicine and rehabilitation, 90(8), 1317–1324. https://doi.org/10.1016/j.apmr.2009.01.030

Volpato, S., Cavalieri, M., Sioulis, F., Guerra, G., Maraldi, C., Zuliani, G., Fellin, R., eta Guralnik, J. M. (2011). Predictive value of the Short Physical Performance Battery following hospitalization in older patients. The journals of gerontology. Series A, Biological sciences and medical sciences, 66(1), 89–96. https://doi.org/10.1093/gerona/glq167

Wade, D. T., eta Collin, C. (1988). The Barthel ADL Index: a standard measure of physical disability?. International disability studies, 10(2), 64-67.

White, T. A., eta LeBrasseur, N. K. (2014). Myostatin and sarcopenia: opportunities and challenges - a mini-review. Gerontology, 60(4), 289–293. https://doi.org/10.1159/000356740

WHO: World Health Organization. (2007). Global age-friendly cities. Retrieved from: https://www.who.int/ageing/publications/Global_age_friendly_cities_Guide_English.pdf

Wilson, R. S., Hebert, L. E., Scherr, P. A., Dong, X., Leurgens, S. E., eta Evans, D. A. (2012). Cognitive decline after hospitalization in a community population of older persons. Neurology, 78(13), 950-956. https://doi.org/10.1212/WNL.0b013e31824d5894

Witard, O. C., McGlory, C., Hamilton, D. L., eta Phillips, S. M. (2016). Growing older with health and vitality: a nexus of physical activity, exercise and nutrition. Biogerontology, 17(3), 529-546. https://doi.org/10.1007/s10522-016-9637-9

Wolinsky, F. D., Miller, D. K., Andresen, E. M., Malmstrom, T. K., Miller, J. P., eta Miller, T. R. (2007). Effect of subclinical status in functional limitation and disability on adverse health outcomes 3 years later. The journals of gerontology series a: biological sciences and medical sciences, 62(1), 101-106. https://doi.org/10.1093/gerona/62.1.101

Yarasheski, K. E., Bhasin, S., Sinha-Hikim, I., Pak-Loduca, J., eta Gonzalez-Cadavid, N. F. (2002). Serum myostatin-immunoreactive protein is increased in 60-92 year old women and men with muscle wasting. Journal of nutrition health and aging, 6(5), 343-348.

Yoo, S. Z., No, M. H., Heo, J. W., Park, D. H., Kang, J. H., Kim, S. H., eta Kwak, H. B. (2018). Role of exercise in age-related sarcopenia. Journal of exercise rehabilitation, 14(4), 551-558. https://doi.org/10.12965/jer.1836268.134

Zaleski, A. L., Taylor, B. A., Panza, G. A., Wu, Y., Pescatello, L. S., Thompson, P. D., eta Fernandez, A. B. (2016). Coming of age: considerations in the prescription of exercise for older adults. Methodist DeBakey cardiovascular journal, 12(2), 98. 98–104. https://doi.org/10.14797/mdcj-12-2-98

8. ERANSKINAK / APPENDIX

1. ERANSKINA:

Informazio orria eta baimen informatua

1. APPENDIX:

Fact sheet and informed consent

CONSENTIMIENTO PARA LA REALIZACIÓN DEL PROYECTO DE INVESTIGACIÓN

Investigador/Responsable clínico: Dra. Ariadna Besga

TÍTULO DEL PROYECTO: Efectos de un programa de ejercicio y suplementación nutricional con proteínas sobre la masa muscular, capacidad funcional y cognitiva y la calidad de vida en personas mayores de 75 años de edad: Estudio aleatorizado controlado

Yo…… con DNI…..
declaro bajo mi responsabilidad que he leído la Hoja de Información al paciente, de la que se me ha entregado una copia. Se me han explicado las características y el objetivo del estudio, así como los posibles beneficios y riesgos que puedo esperar, los derechos que puedo ejercitar, y las previsiones sobre el tratamiento de datos y muestras. Se me ha dado tiempo y oportunidad para realizar preguntas, que han sido respondidas a mi entera satisfacción.

Sé que se mantendrá en secreto mi identidad y que se identificarán mis muestras con un sistema de codificación. Soy libre de revocar mi consentimiento en cualquier momento y por cualquier motivo, sin tener que dar explicación y sin que repercuta negativamente sobre cualquier tratamiento médico presente o futuro.

Yo doy mi consentimiento para que se utilicen mis muestras y los datos asociados como parte de **este proyecto de investigación**. Consiento en participar voluntariamente y renuncio a reclamar cualquier beneficio económico por mi participación en el estudio.

Por la presente afirmo haber sido advertido sobre la posibilidad de recibir información relativa a mi salud derivada de los análisis genéticos que se realicen sobre mi muestra biológica.

Yo solicito información □

Yo no quiero recibir información □

una vez finalizada la investigación sobre los resultados del estudio.

Si hubiera excedente de la muestra, afirmo haber sido advertido sobre las opciones de destino al finalizar el proyecto de investigación.

En este sentido:

☐ Solicito la destrucción de la muestra excedente

☐ No solicito la destrucción de la muestra excedente

Fecha ……. Firma del paciente ……..

Fecha …….. Firma representante legal (si procede)……..

Nombre representante legal: Relación con el paciente:

Constato que he explicado las características del proyecto de investigación y las condiciones de conservación y seguridad que se aplicarán a la muestra y a los datos conservados.

Nombre del Investigador o la persona designada para proporcionar la

información: Fecha …… Firma ……

CONSENTIMIENTO DONACIÓN DE MUESTRAS AL BIOBANCO VASCO PARA LA INVESTIGACIÓN

Responsable clínico: Dra. Ariadna Besga

Yo _____

He sido informado sobre la posibilidad de transferir y almacenar la muestra junto con la información clínica relacionada al Biobanco Vasco para la Investigación.

He sido informado sobre la finalidad de la **conservación,** el lugar de conservación, así como sobre las garantías de cumplimiento de la legalidad vigente y de la posibilidad de ceder las muestras para futuros proyectos de investigación. Se me ha informado que el presente consentimiento será custodiado en las instalaciones del Biobanco en el Hospital Universitario de Araba.

Yo **DOY** mi consentimiento para que el centro sanitario Hospital Universitario de Araba (sede Santiago) transfiera mis muestras y los datos de salud relevantes (excepto los que me identifiquen) al proceso de Sarcopenia, al Biobanco Vasco para la Investigación.

Se me ha advertido sobre la posibilidad de consentir en donar la muestra y los datos asociados de forma anonimizada:
DESEO QUE LAS MUESTRAS Y DATOS ESTÉN ANONIMIZADOS** ☐
DESEO QUE LAS MUESTRAS Y DATOS ESTÉN CODIFICADOS* ☐

Se me ha advertido sobre la posibilidad de recibir información relativa a mi salud derivada de futuros análisis genéticos que pudieran realizarse sobre mi muestra biológica (si la muestra se ha donado codificada y se han obtenido datos genéticos).
Yo solicito información ☐
Yo no quiero recibir información ☐

Fecha …… Firma del paciente ……

Fecha :…….. Firma representante legal (si procede)……..

Nombre representante legal:

Relación con el paciente:

Constato que he explicado las características de las condiciones de conservación y seguridad que se aplicarán a la muestra y a los datos clínicos conservados.

Nombre del clínico responsable

Fecha …… Firma ……

*****muestra codificada: la muestra se identifica con un número que sólo su médico o el coordinador del Biobanco Vasco en su hospital podrá relacionarla con usted

**muestra anonimizada es aquella no asociada con los datos identificativos

ANEXO ACLARATORIO

SE GARANTIZA QUE LA REALIZACIÓN DE ESTE PROYECTO, EL TRATAMIENTO, ALMACENAMIENTO Y UTILIZACIÓN DE LAS MUESTRAS ALMACENADAS EN EL BIOBANCO CUMPLIRÁN CON LA **NORMATIVA APLICABLE**:

Ley Orgánica 15/1999, de 13 de diciembre, de Protección de Datos de Carácter Personal. En observancia a esta ley los datos de carácter personal recogidos en este estudio pasarán a formar parte de un fichero automatizado que reúne las medidas de seguridad de nivel alto.

Ley 41/2002, de 14 de noviembre, básica reguladora de la autonomía del paciente y de derechos y obligaciones en materia de información y documentación clínica

Ley 14/2007, de 3 de julio, de Investigación biomédica.

¿QUÉ ES UN BIOBANCO?

Un **biobanco** es un centro de conservación, en condiciones adecuadas, de muestras, tejidos, ADN y otros derivados, que representan un valioso instrumento con destino a la investigación de enfermedades y que puede permitir la obtención de conocimientos que sirvan para el desarrollo de nuevas estrategias y terapias aplicables a pacientes.

El Biobanco de BIOEF está constituido en nodos, uno de los cuales está ubicado en el Hospital Universitario Araba, en donde se almacenará y conservará su muestra

Los proyectos de investigación realizados con las muestras almacenadas en el Biobanco serán aprobados por un Comité de Ética de la Investigación, y, si procede, autorizado por la autoridad sanitaria pertinente, previo vio informe favorable de los comités ético y científico externos del biobanco.

Tanto el Biobanco Vasco para la Investigación, como el investigador al que en un futuro se puedan ceder las muestras, son responsables del manejo de los Datos, conforme a la Ley orgánica 15/1999, de 13 de diciembre, sobre Protección de Datos de Carácter Personal. El Hospital Universitario Araba garantiza que en ningún caso saldrá del centro dato alguno que le identifique personalmente.

2. ERANSKINA:

Informazio-saioak eta informazio-triptikoak

2. APPENDIX:

Information sessions and brochures

Frogatuta dago ospitalizazioan zehar jarduera fisikoa egiteak:

- Indar eta egoera fisikoa mantentzen zein hobetzen laguntzen duela.
- Oreka hobetzen eta beraz eroriak prebenitzen laguntzen duela.
- Diabetesa, osteoporosia edo bihotz gaitzak maneiatzen eta hobetzen laguntzen duela.
- Egoera animikoa, memoria eta ongizate orokorra hobetzen laguntzen duela.
- Depresio sentipenak murrizten laguntzen duela.
- Egunerokotasuneko jarduerak, hala nola, ohetik edo aulkitik altxa, jantzi eta dutxatzea errazagoak izatera laguntzen duela.
- Desio diren eguneroko gauzak egitea errazten duela.

Aldaketa txikiek ere norbanakoaren funtzioan diferentziak lor ditzakete, ondorioz baita AUTONOMIAN ere

Saio informatiboak
Asteazken guztietan 12:00etan
Florida aretoa, 1. solairua
AUO Santiago

3. solairua, B pabiloia
AUO Santiago
15 kontsulta
Tel.: 945007728

Gomendio hauek Araba ESIk eta Euskal Herriko Unibertsitateak kolaboratzen duten “Intervención integral en Sarcopenia & Fragilidad” proiektuaren barne ezarriak daude.

Proiektuaren izenburua honakoa izanik: “Efectos de un programa de ejercicio y suplementación nutricional sobre la masa muscular, capacidad funcional y cognitiva y la calidad de vida en personas mayores de 75 años de edad: Estudio aleatorizado controlado”.

Kodea 2016111138

Ospitalizazioan jarduera fisikoa egiteko gomendioak

Osakidetza
ARABA ERAKUNDE SANITARIO INTEGRATUA
ORGANIZACIÓN SANITARIA INTEGRADA ARABA

Universidad del País Vasco
Euskal Herriko Unibertsitatea

EUSKO JAURLARITZA
GOBIERNO VASCO
OSASUN SAILA
DEPARTAMENTO DE SALUD

1. MAILA

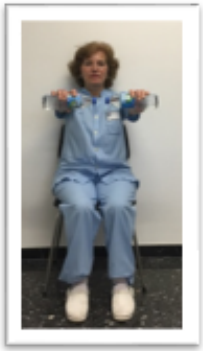
Esku-haurrean pilota bigun bat eutsi, pilota estutu eta eutsi segundu batzuetan.

Ohean etzanda belaunak tolestu. Pesak (botilak) izter gainean ezarri eta besoak luzatuta mantenduz sorbalden altuerara igo.

Ohean etzanda, belaunak tolestu. Eskuekin lagunduta, belauna bularralderantz eraman. Ariketa hau bi hankarekin egizu.

10 – 12 aldiz errepikatu ariketa bakoitza
Hanken eta besoen ariketak tartekatu.
Egunean zehar errepikatu ariketa bakoitza

2. MAILA



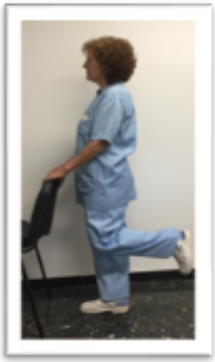
Ondo eserita, bizkarra zuzen eta oinak lurrean dituzula, mantendu pesak (botilak) izter gainean besoak luzaturik dituzula.
Besoak sorbalden altuerara igo.

Ondo eserita, bizkarra zuzen eta oinak lurrean dituzula, oina lurretik altxatu (izterra igo gabe), belauna zuzen mantendu.

Ondo eserita, bizkarra zuzen eta oinak lurrean dituzula, oinak puntilletan jarri eta jarraian orpoak bajatu eta puntak altxatu (punta-orpoa).

3. MAILA

Aulkia eskuekin eutsita duzula, bizkarra aurreratu. Sorbaldak zuzen dituzula, gorputza erabili aulkitik altxatzeko.



Zutik jarri aulki/mahai bateri eutsita oreka mantentzeko. Belauna tolestu oina lurretik altxatuz eta gluteora eraman.

Egunean zehar hainbat aldiz ibili oinetako egokia jantzita (zapata itxiak).

Laguntza behar baduzu erabili ezazu (taka-taka, makulua, muleta).

Osakidetza
ARABA ERAKUNDE SANITARIO INTEGRATUA
ORGANIZACIÓN SANITARIA INTEGRADA ARABA

SESIÓN INFORMATIVA SOBRE CÓMO MANTENER LA MOVILIDAD Y AUTONOMÍA DURANTE EL INGRESO HOSPITALARIO Y EN EL HOGAR

eman ta zabal zazu
Universidad del País Vasco
Euskal Herriko Unibertsitatea

CHARLAS DIRIGIDAS A:

- Pacientes
- Familiares
- Cuidadores
- Personal sanitario
- Interesados

DÍA: Todos los miércoles hasta junio de 2018.
HORA: 12:00.

LUGAR: 1ª planta - Pabellón B - Sala Florida - HUA Santiago

Proyecto de Intervención Integral en Sarcopenia & Fragilidad (2016111138)

EUSKO JAURLARITZA
GOBIERNO VASCO
OSASUN SAILA
DEPARTAMENTO DE SALUD

Osakidetza
ARABA ERAKUNDE SANITARIO INTEGRATUA
ORGANIZACIÓN SANITARIA INTEGRADA ARABA

ERIETXEKO EGONALDIAN ZEHAR ETA ETXEAN MUGIKORTASUNA ETA AUTONOMIA MANTENTZEAREN INGURUKO SAIO INFORMATIBOA

eman ta zabal zazu
Universidad del País Vasco
Euskal Herriko Unibertsitatea

NORENTZAT:

- Pazienteak
- Senideak
- Zaintzaileak
- Osasun zerbitzuko langileak
- Interesatuak

EGUNA: Asteazken guztietan 2018ko ekaina arte.
ORDUA: 12:00.

LEKUA: 1. solairuan – B pabiloia – Florida aretoa - AUO Santiago

Proyecto de Intervención Integral en Sarcopenia & Fragilidad (2016111138)

EUSKO JAURLARITZA
GOBIERNO VASCO
OSASUN SAILA
DEPARTAMENTO DE SALUD

3. ERANSKINA:

Talde-saioak eta egutegia

3. APPENDIX:

Group sessions and timetable

OSPITALEAN EGITEKO ARIKETAK

GIROTZE ALDIA (5-10 MINUTU)

MUGIKORTASUN ARTIKULARRA

- LEPOA:
  - Burua gora eta behera mugitu, eta jarraian ezker eta eskuinera.
- SORBALDA:
  - Gora eta behera mugitu.
- BESOAK:
  - Eskuekin belaunak eta sorbaldak ukituz
- ESKUAK:
  - 5 segundoz pilota bat estutuz esku batekin zein birekin
- HANKAK:
  - Belaunak igo eta jaitsiz (eserita)
  - Oin puntak eta orpoak igo eta jaitsiz (zutik)

ATAL NAGUSIA (30-40 MINUTU)

INDARRA

EGOKITZAPEN FASEAN, lehenengo hiru asteetan, 4-5 ariketa egin ziren, 2 serie eta 8-12 errepikapenarekin. Indar entrenamendua, egin ahal zuten indar maximoaren (RM1) %40-50-eko intentsitatean hasi zuten. Kargaren bolumena eta intentsitatea handitzen joan ziren parte hartzaileen arabera. Serieen artean 1-3 minututako atsedena izan zuten. Ariketa batzuetan, ariketaren konplexutasuna zela eta, ez zen material gehigarririk erabili. Beste ariketa batzuetan ordea exekuzio abiaduran aldaketak gauzatu ziren potentzia lantzeko asmoz.

INDAR GARAPENAREN FASEAN, laugarren astetik hamabigarren astera bitarte ariketa berberak gauzatu ziren, bakoitzean 8-12 errepikapeneko 2 serie eginez intentsitate moderatuan, alegia RM1-ko %60-70.

- BESO-FLEXIOA (Bizepsa)
  - Asteko bi saioetan eta pisu gehigarriarekin egiten zen
  - Aurretik aipatutako printzipioetan oinarrituta intentsitatea doitu zen.
    - 1-3 asteak: % 40-50 eta 4-12asteak: % 60-70


- ALTXA ETA ESERI
    - Asteko bi saioetan eta pisu gehigarririk gabe egiten zen.
    - Kasu honetan intentsitateari dagokionez progresioa honela gauzatu genuen. <RM1-eko proba egitean 10 errepikapen baino gehiago burutzen zituzten parte-hartzaileetan, serie bakoitzean 10 errepikapen burutu zituzten bukaeran 12ra iritsi arte. Beti ariketaren kontrola zutenean ahalik eta azkarren burutzeko azpimarratzen zitzaien. Aldiz, RM1-ko proban 10 errepikapen edo gutxiago burutu ahal zituztenak, programak zehazten zuen intentsitatearen arabera doitzen zitzaien errepikapen kopurua. Exekuzio abiadurari dagokionez gaitasun hori lantzeko zuten parte-hartzaileetan egoera kontzentrikoan potentzia mugimendua gauzatzen zuten eta eszentrikoan mugimendu arina.


- BERNA (PUNTA-ORPO)
    - Asteko bi saioetan eta pisu gehigarririk gabe egiten zen.
    - Kasu honetan beroketaren azken ariketa izan arren indar garapenaren fasean exekuzio abiadurari dagokion aldaera sartu zen. Gaitasun hori lantzeko teknika kontrol egokia zuten parte-hartzaileetan egoera kontzentrikoan potentzia mugimendua gauzatzen zuten eta eszentrikoan mugimendu arina.
- GLUTEO MUSKULU ERTAINA
    - Asteko lehen saioan eta pisu gehigarririk gabe egiten zen.
    - Interbentzioa doitzeko egin genuen proba pilotuan zein gure aurretiko esperientzian oinarrituz pisu gehigarri gabe burutzea erabaki genuen. Denek 10 edo 12 errepikapen burutu zituzten.
- BELAUN TOLESTEA (ISKIOTIBIALA)
    - Asteko lehen saioan eta pisu gehigarriarekin egiten zen.
    - Aurretik aipatutako printzipioetan oinarrituta intentsitatea doitu zen.
        - 1-3 asteak: %40-50
        - 4-12 asteak: % 60-70

- GLUTEO MUSKULU HANDIA
    - Asteko bigarren saioan eta pisu gehigarririk gabe egiten zen.
    - Interbentzioa doitzeko egin genuen proba pilotuan zein gure aurretiko esperientzian oinarrituz pisu gehigarri gabe burutzea erabaki genuen. Denek 10 edo 12 errepikapen burutu zituzten.


- BELAUN LUZATZEA (KOADRIZEPS)
    - Asteko bigarren saioan eta pisu gehigarriarekin egiten zen.
    - Aurretik aipatutako printzipioetan oinarrituta intentsitatea doitu zen.
        - 1-3 asteak: %40-50
        - 4-12 asteak: % 60-70


<u>OREKA</u>

- LEHENENGO FASEAN, lehenengo hiru asteetan, helburu nagusia ariketen ezagutza eta eserita zein zutik (beti euskarrien bitartez) bakoitzaren konfiantza areagotzea izan zen. Oreka estatikoa zutik landu zen, eta oreka dinamikoa, eserita. Saio bakoitzean 2 edo 3 oreka ariketa burutzen ziren.
- BIGARREN FASEAN, laugarren astetik hamabigarren astera bitarte, aurretiko oreka ariketak zailtzen joateaz gain beste berri batzuk gehitu ziren. Fase honetan, oreka

estatikoa eta dinamikoa zutik landu genituen. Saio bakoitzean laupabost ariketa burutu ziren.

- Oreka estatikoa zutik:
  - Asteko lehen zein bigarren saietan gauzatzen ziren. Beti ere beharrezkoa ikusiko bagenu euskarriaren laguntza erabiltzen zen.
    - Lehen saioa: Bi oinak elkarrekin eta semi-tandem.
    - Bigarren saioa: Tandem eta oin bakarrean (monopodal) mantenduz.
  - Ariketa honen zailtasuna, bigarren fasean euskarrien kentzearekin edo beste aldaerak sartuz (begi bat edo biak itxita) gauzatu zen.


- Oreka dinamikoa eserita:
  - Lehen fasearen asteko lehen saioan gauzatzen zen
  - Parte-hartzaileak bata bestearen parean eserita zeudela kideari baloia pasa (bota ez) behar zioten. Pixkanaka bata bestearen lekutik urrutiago jarrita 10-15 errepikapen egiten zituzten
  - Ariketa hau bigarren fasean zutik binaka edo taldeka borobilean gauzatu zen.
- Oreka dinamikoa zutik:
  - Lehen fasean asteko bigarren saioan gauzatu zen.
    - Lehen saioa: Parte-hartzaileak step baten aurrean zutik daudelarik, oin bat eta gero bestea step-aren gainean jarri behar zuten (euskarriaren laguntzaz beharrezkoa ikusiko bagenu).
  - Bigarren fasean ariketa berriak eta aurrez eserita egin zirenak gehitu ziren. Beraz oreka dinamikoa bi saioetan landu zen.
    - Bigarren saioa: Baloia taldekideei aurrez aurre edo borobilean pasa behar diete (beti euskarri bat hurbil izanik).
    - Lehen eta bigarren saioa: Parte-hartzaileek hainbat bira dituzten zirkuitu motz batzuk egin behar zituzten.

LAN AEROBIKOA

Atal hau ospitaleko korridorean zein saioa ematen zen gelan lantzen zen. Ibilaldi motz zein ertainak egiten ziren. Distantziak ez zirenez luzeak gehienez 60 eta gutxienez 10 metroko itzuliak lantzen ziren, beti arrisku guztiak ekidinez eta oinezko abiadura desberdinekin (arina eta azkarra). Baita ere ibiltzeko gomendioak ematen zitzaizkien.

LASAITZE/ERLAXAZIO ALDIA (5-10 MINUTU)

MALGUTASUNA

Pilota bat hartu eta hau mugituz pixkanaka oin puntara eramanez. Tinkotasun edo deserosotasun arina (minik ez) nabaritzen zuten puntuan geratu, eta bertan 20-30 segundoz jarrera mantendu behar zuten. Arnasketa ez zen eutsi edo blokeatu behar (apneak). Honako hau hanka bakoitzarekin bi hiru aldiz gauzatu behar zuten.

ERLAXAZIO ARIKETAK

Begiak itxi eta arnasketa sakonak burutu beti ere erlaxatzeko helburuarekin.

Arabako Unibertsitate Ospitalea

2017ko Abendua (Gasteiz)

ASTELEHENA	ASTEARTEA	ASTEAZKENA	OSTEGUNA	OSTIRALA	LARUNBATA	IGANDEA
27	28	29	30	1	2	3
4	5 10:45 SAIOA	6	7 10:45 SAIOA	8	9	10
11	12 10:45 SAIOA	13	14 10:45 SAIOA	15	16	17
18	19 10:45 SAIOA	20	21 10:45 SAIOA	22	23	24
25	26 10:45 SAIOA	27	28 10:45 SAIOA	29	30	31

Arabako Unibertsitate Ospitalea

2018ko Urtarrila (Gasteiz)

ASTELEHENA	ASTEARTEA	ASTEAZKENA	OSTEGUNA	OSTIRALA	LARUNBATA	IGANDEA
1	2 10:45 SAIOA	3	4 10:45 SAIOA	5	6	7
8	9 10:45 SAIOA	10	11 10:45 SAIOA	12 AZELEROMETROAK	13	14
15	16 AZELEROMETROAK	17	18	19 PROBA FISIKOAK	20	21
22	23	24	25	26	27	28
29	30	31	1	2	3	4

4. ERANSKINA:

Etxean egiteko ariketen astekaria

4. APPENDIX:

Weekly home activities timetable

ASTELEHENA	ASTEARTEA	ASTEAZKENA	OSTEGUNA	OSTIRALA	LARUNBATA	IGANDEA
Eskuko indarra 8. orrialdea	**Eskuko indarra** 8. orrialdea	**Eskuko indarra** 8. orrialdea	**Eskuko indarra** 8. orrialdea	**Eskuko indarra** 8. orrialdea	**Eskuko indarra** 8. orrialdea	**Malgutasuna** 30-35 orrialdeak
Eskumuturreko indarra 1kg 12. orrialdea	**Bernako indarra** 14 eta 15. orrialdeak	**Sorbaldako indarra 1kg** 9 eta 10.orrialdeak	**Bernako indarra** 14 eta 15. orrialdeak	**Eskumuturreko indarra 1kg** 12. orrialdea	**Sorbaldako indarra 1kg** 9 eta 10.orrialdeak	**Oreka** Gainbegiratzearekin! 22-26 orrialdeak
Bicepseko Indarra 4kg 11.orrialdea	**Gluteo handiko indarra** 16. orrialdea	**Bernako indarra** 14 eta 15.orrialdeak	**Gluteo handiko indarra** 16. orrialdea	**Bicepseko Indarra 4kg** 11.orrialdea	**Bernako indarra** 14 eta 15. orrialdeak	**Malgutasuna** 30-35 orrialdeak
Bernako indarra 14 eta15.orrialdeak	**Hankako indarra** 21. orrialdea	**Gluteo ertaineko indarra** 17. orrialdea	**Hankako indarra** 21. orrialdea	**Bernako indarra** 14 eta 15. orrialdeak	**Oreka** Gainbegiratzearekin! 22-26 orrialdeak	
Gluteo ertaineko indarra 17. orrialdea	**Kuadrizepseko indarra** 18. orrialdea	**Hankako indarra** 21. orrialdea	**Kuadrizepseko indarra** 18. orrialdea	**Gluteo ertaineko indarra** 17. orrialdea	**Malgutasuna** 30-35 orrialdeak	
Hankako indarra 21. orrialdea	**Oreka** Gainbegiratzearekin! 22-26 orrialdeak	**Ad/Abduktoreen indarra** 20. orrialdea	**Oreka** Gainbegiratzearekin! 22-26 orrialdeak	**Hankako indarra** 21. orrialdea		
Iskiotibialeko indarra 19. orrialdea	**Malgutasuna** 30-35 orrialdeak	**Malgutasuna** 30-35 orrialdeak	**Malgutasuna** 30-35 orrialdeak	**Iskiotibialeko indarra** 19. orrialdea		
Malgutasuna 30-35 orrialdeak				**Malgutasuna** 30-35 orrialdeak		
M. Aerobikoa Ibili/Bizikleta: 45 minutu (Erritmo normalean) 27-29. orrialdeak	**M. Aerobikoa** Ibili/Bizikleta: 45 minutu (Erritmo normalean) 27-29. orrialdeak	**M. Aerobikoa** Ibili/Bizikleta: 45 minutu (Erritmo normalean) 27-29. orrialdeak	**M. Aerobikoa** Ibili/Bizikleta: 45 minutu (Erritmo normalean) 27-29. orrialdeak	**M. Aerobikoa** Ibili/Bizikleta: 45 minutu (Erritmo normalean) 27-29. orrialdeak	**M. Aerobikoa** Ibili/Bizikleta: 45 minutu (Erritmo normalean) 27-29. orrialdeak	**M. Aerobikoa** Ibili/Bizikleta: 45 minutu (Erritmo normalean) 27-29. orrialdeak

LUNES	MARTES	MIÉRCOLES	JUEVES	VIERNES	SÁBADO	DOMINGO
Fuerza de manos página 8	**Fuerza de manos** página 8	**Fuerza de manos** página 8	**Fuerza de manos** página 8	**Fuerza de manos** página 8	**Fuerza de manos** página 8	**Flexibilidad** paginas 30-35
Fuerza Muñeca 1kg página 12	**Fuerza Pantorrila** páginas 14 y 15	**Fuerza Hombros 1kg** página 9 y 10	**Fuerza Pantorrila** páginas 14 y 15	**Fuerza Muñeca 1kg** página 12	**Fuerza Hombros 1kg** página 9 y 10	**Equilibrio** ¡con supervisión! paginas 22-26
Fuerza Biceps 4kg página 11	**Fuerza Glúteo Mayor** página 16	**Fuerza Pantorrila** páginas 14 y 15	**Fuerza Glúteo Mayor** página 16	**Fuerza Biceps 4kg** página 11	**Fuerza Pantorrila** páginas 14 y 15	**Flexibilidad** paginas 30-35
Fuerza Pantorrila páginas 14 y 15	**Fuerza Pierna** página 21	**Fuerza Glúteo Medio** página 17	**Fuerza Pierna** página 21	**Fuerza Pantorrila** páginas 14 y 15	**Equilibrio** ¡con supervisión! paginas 22-26	
Fuerza Glúteo Medio página 17	**Fuerza Cuadrizeps** página 18	**Fuerza Pierna** página 21	**Fuerza Cuadrizeps** página 18	**Fuerza Glúteo Medio** página 17	**Flexibilidad** paginas 30-35	
Fuerza Pierna página 21	**Equilibrio** ¡con supervisión! paginas 22-26	**Fuerza Add/Abductores** página 20	**Equilibrio** ¡con supervisión! paginas 22-26	**Fuerza Pierna** página 21		
Fuerza Isquiotibial página 19	**Flexibilidad** paginas 30-35	**Flexibilidad** paginas 30-35	**Flexibilidad** paginas 30-35	**Fuerza Isquiotibial** página 19		
Flexibilidad paginas 30-35				**Flexibilidad** paginas 30-35		
M. Aeróbico Paseo/Bicicleta: 45 minutos (Ritmo normal) paginas 27-29	**M. Aeróbico** Paseo/Bicicleta: 45 minutos (Ritmo normal) paginas 27-29	**M. Aeróbico** Paseo/Bicicleta: 45 minutos (Ritmo normal) paginas 27-29	**M. Aeróbico** Paseo/Bicicleta: 45 minutos (Ritmo normal) paginas 27-29	**M. Aeróbico** Paseo/Bicicleta: 45 minutos (Ritmo normal) paginas 27-29	**M. Aeróbico** Paseo/Bicicleta: 45 minutos (Ritmo normal) paginas 27-29	**M. Aeróbico** Paseo/Bicicleta: 45 minutos (Ritmo normal) paginas 27-29

5. ERANSKINA:

Bakarkako saioetako ariketa eta gomedioak (etxean)

5. APPENDIX:

Exercises and recommendations for individual sessions (home-based period)

ETXEAN EGITEKO ARIKETAK

JARDUERA FISIKOA. GOMENDIOAK

Gomendio hauek Arabako Unibertsitate Ospitaleak eta Euskal Herriko Unibertsitateak kolaboratzen duten "Intervención integral en Sarcopenia & Fragilidad" proiektuaren barne daude. Proiektuaren izenburua honakoa izaki: *"Efectos de un programa de ejercicio y suplementación nutricional sobre la masa muscular, capacidad funcional y cognitiva y la calidad de vida en personas mayores de 75 años de edad: Estudio aleatorizado controlado "*

Orrialde hauetan aurrera eraman ahal izateko gomendio batzuk adierazi nahi dizkizuegu.

Ospitalizazioan zehar, etxean edo zure bizitokian berauek jorratzera animatzen zaituztegu.

Giharrak indartu eta hauen erresistentzia hobetzeko balio dute. Baita ere oreka eta egoera kardiobaskularra hobetuko dira.

Zure baliabide zein gaitasunetan konfiantza emango dizu, eta horrek epe luzera bizi-kalitate hobeagoa ekarriko dizu.

Aurkezpena

- Indar zein gihar kopuru galerak beste hainbat gauzen artean egunerokotasuneko jardueren murriztea, erorietarako arriskua areagotzea eta autonomia zein independentzia galtzea dakar.
- Gihar funtzioaren galera eta narriaduran jarduera fisiko eza eta sedentarismoa faktore erabakigarriak dira.

Frogatuta dago jarduera fisikoa areagotzeak:

- Indar eta egoera fisikoa mantentzen zein hobetzen laguntzen duela.
- Oreka hobetzen eta beraz eroriak saihesten laguntzen duela.
- Diabetesa, osteoporosia edo bihotz gaitzak maneiatzen eta hobetzen laguntzen duela.
- Egoera animikoa, memoria eta ongizate orokorra hobetzen laguntzen duela.
- Depresio sentipenak murrizten laguntzen duela.
- Egunerokotasuneko jarduerak, hala nola, aulkitik altxa eseri, eskailerak igo, jantzi, dutxatu, poteak ireki edota ilobekin jolastea errazagoak izatera laguntzen duela.
- Desio diren eguneroko gauzak egitea errazten duela.

Aldaketa txikiek ere norbanakoaren funtzioan diferentziak lor ditzakete, ondorioz baita autonomian ere.

Programa egoki gauzatu ahal izateko aholkuak:

- Mina: Ariketak gauzatzen zabiltzan bitartean ez duzu inolako min artikular edo muskular ezgaiturik nabaritu behar.
- Eremua/Tokia: Eroriak prebenitzeko edota arriskua murriztu zein ezabatzeko ariketak gauzatu behar diren tokia/eremua egokia izan behar da. Arrisku oztopoak kendu.
- Elementu eta materiala: Segurtasun handiena ematen dizuten material zein elementuak (aulki, mahai, botila, pisu eta abar) erabili.
- Arropa eta oinetakoak: Arropa eroso eta oinetako egokiak (oin-zola ez irristakorrak eta orpoan sostengu egokia) erabili.
- Arnasketa: Normal arnastu, ariketak egiten zabiltzan bitartean arnasketa ez blokeatzea oso garrantzitsua da. Diafragma bidezko arnasketa gauzatu behar da, alegia, sudurretik arnasa hartu eta ahotik bota behar da.

SEGURTASUN ARAUAK

Jarraian, ariketa fisikoak jorratzen zabiltzan bitartean kontuan hartu beharreko hainbat seinale azalduko dizkizugu. Hauetarikoren bat pairatu eta sentitzen baduzu ariketa fisikoa egiteari utzi eta osasun arloko profesional batengana jo.

- Bularraldean min edo presioa.
- Zorabio, kontzientzia galera edo goragalea.
- Neke/Min handia.
- Haize falta sentsazioa.
- Palpitazioak.
- Izerdi hotza, zurbil egotea.

INDARRA. GOI ATALA

ESKUA ETA BESAURREA

Ariketa honek objektuak hartu edo hauei eusteko garaian arazoak badituzu laguntzeko balio. Baita ere objektuak irekitzeko garaian, poteak adibidez, lagunduko dizu.

Jarraibideak:

▪ Pauso 1

▪ Pauso 2

- Esku-haurrean teniseko pilota edo pilota bigun bat eutsi.
- Pilota poliki-poliki estutu eta 3-5 segundo eutsi.
- Poliki-poliki erlaxatu eskua.

10-12 aldiz errepikatu. Errepikapenen artean 1-2 segundo deskantsatu. Beste eskuarekin 10-12 aldiz errepikatu.

BESOAREN ATZEALDEA

Bultzada mugimendu honek, besoen giharrak indartuko ditu nahiz eta aulkitik altxatu ezin bazara.

Jarraibideak:

▪ Pauso 1 ▪ Pauso 2 ▪ Pauso 3

- Oinak sorbalden zabaleran lurrean jarririk beso-euskarridun aulki erresistente batean eseri. Bizkarra zein sorbaldak zuzen mantenduaz pixka bat aurreraka inklinatu zaitez. Beso-euskarriak eskuekin eutsi, eta lasai arnastu ezazu.
- Arnasa eginez erabili besoak zure gorputza aulkitik urruntzeko (+/- 10cm). Posizio hori 2 segundoz mantendu.
- Arnastu ezazu hasierako posiziora itzultzen zaren bitartean.

10-12 aldiz errepikatu. 1-3 minutu deskantsatu. Berriz, 10-12 aldiz errepikatu.

PEKTORALA ETA SORBALDAK

Flexio hauek beso, sorbalda eta bularraldea indartuko dute.

Jarraibideak:

- Zure besoen luzera baina handiagoko distantzia batean, paretara begira zutik jar zaitez oinak sorbalden zabaleran jarriak dituzularik.

Zure gorputza aurreraka inklinatu esku-ahurrak, sorbalden altueran eta zabaleran, paretan ezarri arte.

- Poliki arnastu ukondoak tolesten dituzula goiko enborra paretarantz hurbiltzen duzun heinean. Mugimendu geldoa bezain kontrolatua izan dadila. Oinak lurrean finko mantenduz posizioa segundo 1 mantendu.
- Arnasa eginez poliki atzeraka bultzatu besoak zuzen izan arte.

10-12 aldiz errepikatu. 1-3 minutu deskantsatu. Berriz, 10-12 aldiz errepikatu.

SORBALDAK ETA BESOAK

Ariketa honek sorbalda zein besoak indartuko dizkizu. Ariketa hau zutunik edota aulki erresistente batean eserita egin dezakezu.

Jarraibideak:

- Aulki erresistente batean eseri oinak sorbalden zabaleran lurrean jarrita dituzula. Pesak (botilak) irudian adierazten den moduan mantendu esku-ahurrak aurrerantz dituzula.
- Arnasa egin bi besoak batera buru gainetik luzatzen dituzun bitartean. Ukondoak arinki tolestuak mantenduz posizio horretan 2-3 segundo iraun.
- Arnastu poliki besoak jaisten dituzun bitartean hasierako posizioa berreskuratu arte.

10-12 aldiz errepikatu. 1-3 minutu deskantsatu. Berriz, 10-12 aldiz errepikatu.

SORBALDAK ETA BESOAK

Ariketa honek apal batean gauzak uzten edota bertatik gauzak errazago hartzen lagunduko dizu. Ariketa hau etzanda, zutunik edota aulki erresistente batean eserita egin dezakezu.

Zutik egiteko jarraibideak:

▪ Pauso 1 ▪ Pauso 2 ▪ Pauso 3

- Zutik zaudela, oinak lurrean sorbalden zabaleran jarri. Pesak (botilak) izter gainean ezarri besoak luzaturik dituzula.
- Besoak luzatuta mantenduz arnasa egin hauek sorbalden altuerara igotzen dituzun bitartean. Posizio horretan 2 segundoz iraun.
- Arnastu poliki besoak jaisten dituzun bitartean hasierako posizioa berreskuratu arte.

10-12 aldiz errepikatu. 1-3 minutu deskantsatu. Berriz, 10-12 aldiz errepikatu.

Eserita egiteko jarraibideak:

▪ Pauso 1 ▪ Pauso 2 ▪ Pauso 3

- Aulki erresistente batean eseri oinak sorbalden zabaleran lurrean jarrita dituzula. Pesak (botilak) izter gainean ezarri besoak luzaturik dituzula.
- Besoak luzatuta mantenduz arnasa egin hauek sorbalden altuerara igotzen dituzun bitartean. Posizio horretan 2 segundoz iraun.
- Arnastu poliki besoak jaisten dituzun bitartean hasierako posizioa berreskuratu arte.

10-12 aldiz errepikatu. 1-3 minutu deskantsatu. Berriz, 10-12 aldiz errepikatu.

Etzanda egiteko jarraibideak:

▪ Pauso 1

▪ Pauso 2

▪ Pauso 3

- Ohean etzanda belaunak tolestu eta oinak sorbalden zabaleran jarri. Pesak (botilak) izter gainean ezarri besoak luzaturik dituzula.
- Besoak luzatuta mantenduz arnasa egin hauek sorbalden altuerara igotzen dituzun bitartean. Posizio horretan 2 segundoz iraun.
- Arnastu poliki besoak jaisten dituzun bitartean hasierako posizioa berreskuratu arte.

10-12 aldiz errepikatu. 1-3 minutu deskantsatu. Berriz, 10-12 aldiz errepikatu.

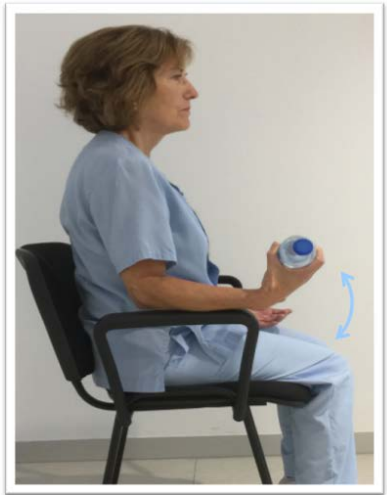
ESKUMUTURRA ETA BESAURREA

Ariketa honek eskumuturrak indartuko dizkizu. Baita ere goi ataleko indar ariketak egiten dituzunean lesioak ekiditeko balioko dizu.

Jarraibideak:

▪ Pauso 1

▪ Pauso 2



- Oinak lurrean sorbalden zabaleran jarrita dituzula beso-euskarriak dituen aulki erresistente batean eseri. Besoetako bat beso-euskarri batean ezarri eskua ertzean duzula.
- Pesa (botila) esku-ahurra gorantza duzula mantendu. Eskumuturra oso poliki lehenik gorantza tolestu eta bigarrenik beherantz.
- Hasierako posiziora itzuli.

10-12 aldiz errepikatu. 1-3 minutu deskantsatu. Berriz, 10-12 aldiz errepikatu.

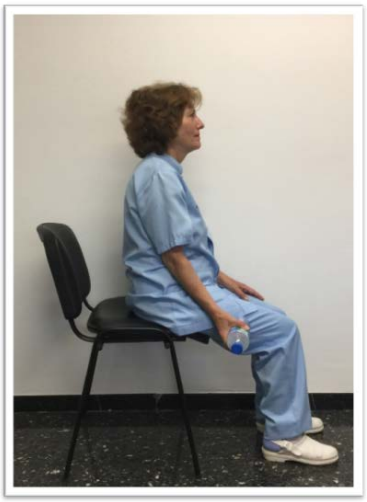
Beste eskuarekin berdina errepikatu.

BIZEPSA

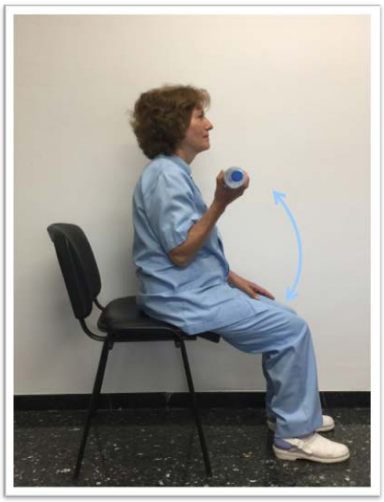
Ariketa honek besoak indartuko dizkizu. Baita ere pisu asko edo erosketak hartzen dituzunean lesioak ekiditeko balioko dizu.

Jarraibideak:

▪ Pauso 1



▪ Pauso 2



- Oinak lurrean sorbalden zabaleran jarrita dituzula aulki erresistente batean eseri. Beso bat alde bereko izterraren alboan eskumuturra zurrun eta eskua-ahurra gorantz duzula jarri.
- Pesa (botila) ongi eutsita mantendu.
  Arnas lasai egin ukondoa sorbaldarantz poliki-poliki tolesten duzun bitartean.
- Hasierako posiziora itzuli.

10-12 aldiz errepikatu. 1-3 minutu deskantsatu. Berriz, 10-12 aldiz errepikatu.

Beste eskuarekin berdina errepikatu

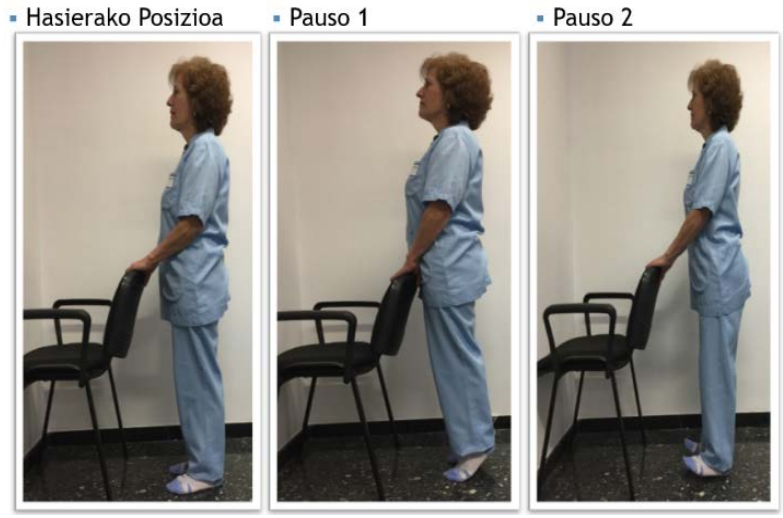
INDARRA.BEHE ATALA

BERNA (PUNTA-ORPO)

Ariketa honek ibilera erraztuko dizu berna eta orkatilak indartuz. Ariketa hau etzanda, zutunik edota aulki erresistente batean eserita egin dezakezu.

Zutik egiteko jarraibideak:

Hasierako Posizioa: Zutik, oinak sorbalden zabaleran dituzula, aulki/mahai baten atzean honi eutsita jarri oreka mantentzeko.



- Kontzentratu poliki arnasten duzun bitartean. Arnas egin eta puntilletan (oin punten gainean) ahalik eta altuen jar zaitez. Posizio hori 1-3 segundoz mantendu. Lasaitasunez arnastu poliki orpoak lurrera jaisten dituzun bitartean.
- Jarraian oin puntak altxatu eta oina soilik orpo gainean ezarri.

10-12 aldiz errepikatu. 1-3 minutu deskantsatu. Berriz, 10-12 aldiz errepikatu.

Eserita egiteko jarraibideak:

Hasierako Posizioa: Aulki egonkor batean eseri oinak lurrean sorbalden zabaleran jarrita dituzula.

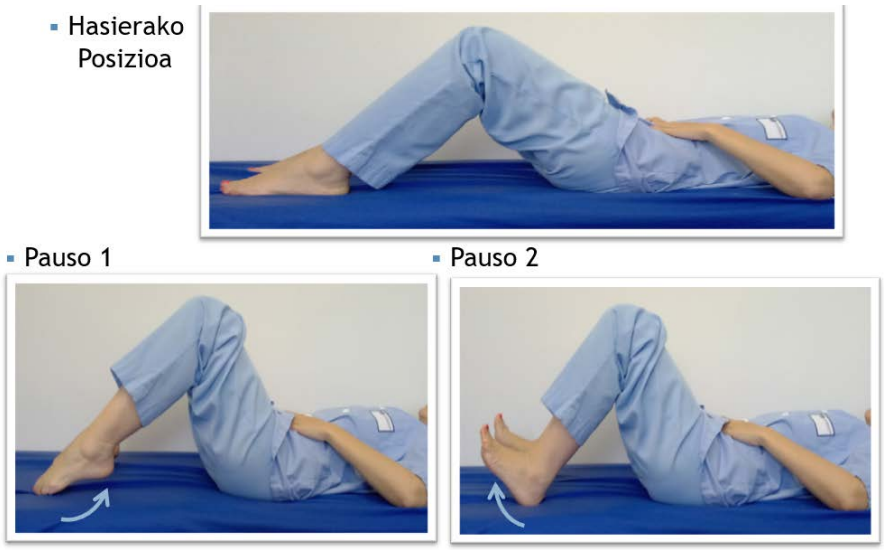
- Kontzentratu poliki arnasten duzun bitartean.

  Arnas egin eta puntiletan (oin punten gainean) ahalik eta altuen jar zaitez. Posizio hori 1-3 segundoz.
  Lasaitasunez arnastu poliki orpoak lurrera jaisten dituzun bitartean.
- Jarraian oin puntak altxatu eta oina soilik orpo gainean ezarri.

10-12 aldiz errepikatu. 1-3 minutu deskantsatu. Berriz, 10-12 aldiz errepikatu.

Etzanda egiteko jarraibideak:

Hasierako Posizioa: Ohean etzanda belaunak tolestu eta eskuak sabelean dituzula oinak sorbalden zabaleran jarri.



- Kontzentratu poliki arnasten duzun bitartean. Arnas egin eta puntiletan (oin punten gainean) ahalik eta altuen jar zaitez. Posizio hori 1-3 segundoz mantendu. Lasaitasunez arnastu poliki orpoak lurrera jaisten dituzun bitartean.
- Jarraian oin puntak altxatu eta oina soilik orpo gainean ezarri.

10-12 aldiz errepikatu. 1-3 minutu deskantsatu. Berriz, 10-12 aldiz errepikatu.

HANKA (TOLESTE HIRUKOITZA)

Ariketa honek hankak indartzen eta mugikortasuna handitzen lagunduko dizu. Ariketa hau bi hankekin batera edo hanka bakoitzarekin egin daiteke.

Jarraibideak:

- Hasierako Posizioa: Ohean etzanda belaunak tolestu eta eskuak tripan dituzula oinak sorbalden zabaleran jarri.
- Kontzentratu zaitez poliki arnasten duzun bitartean. Arnas egin eta bi belaunetako bat bularralderantz eraman, ahalik eta hurbilen jarriaz. Eskuekin lagun zaitez. Posizio hori 1-3 segundoz mantendu.
- Arnastu poliki hasierako posiziora itzultzen zaren bitartean.

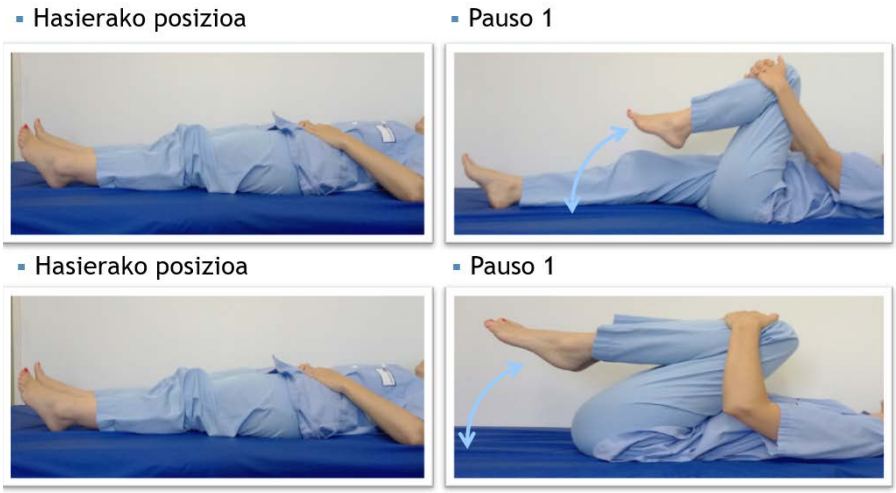
10-12 aldiz errepikatu. 1-3 minutu deskantsatu. Berriz, 10-12 aldiz errepikatu.

HANKA (TOLESTE HIRUKOITZA)

Ariketa honek hankak indartzen eta mugikortasuna handitzen lagunduko dizu. Ariketa hau bi hankekin batera edo hanka bakoitzarekin egin daiteke.

Jarraibideak:

Hasierako Posizioa: Ohean etzanda hankak luzaturik eta eskuak tripan dituzula oinak sorbalden zabaleran jarri.



- Kontzentratu zaitez poliki arnasten duzun bitartean.

  Arnas egin eta bi belaunetako bat bularralderantz eraman, ahalik eta hurbilen jarriz. Eskuekin lagun zaitez. Posizio hori 1-3 segundoz mantendu.

- Arnastu poliki hasierako posiziora itzultzen zaren bitartean.

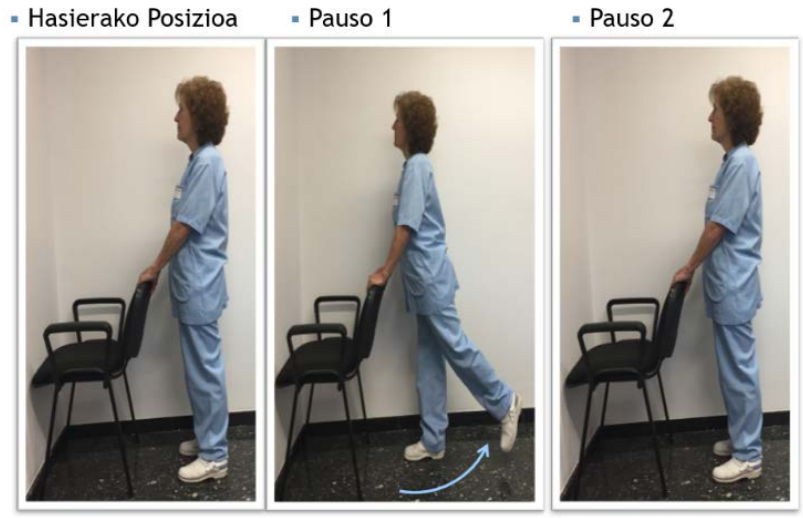
10-12 aldiz errepikatu. 1-3 minutu deskantsatu. Berriz, 10-12 aldiz errepikatu.

ALDAKAREN LUZAKETA (GLUTEO HANDIA)

Ariketa honek ipurmasail eta bizkar behealdea indartuko dizkizu.

Jarraibideak:

Hasierako Posizioa: Zutik, oinak sorbalden zabaleran dituzula, aulki/mahai baten atzean honi eutsita jarri oreka mantentzeko.

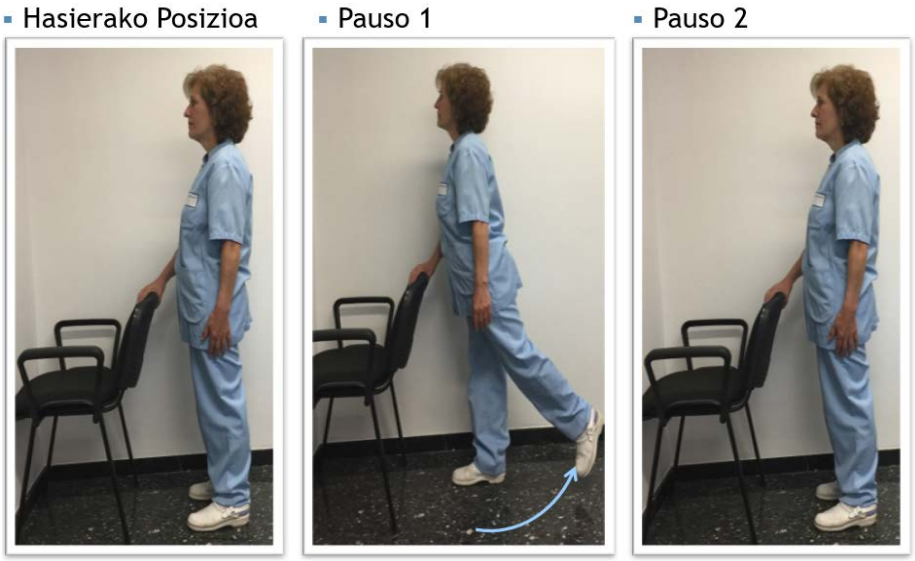


- Kontzentratu poliki arnasten duzun bitartean.
  Arnas egin eta belauna tolestu gabe poliki hanka atzerantz mugitu. Saiatu aurrerantz ez inklinatzen. Sostengu hanka arinki tolestua egon behar du.
- Posizio horretan segundo 1 iraun. Arnastu poliki hanka hasierako posiziora jaisten duzun bitartean.

10-12 aldiz errepikatu, hankak tartekatuz. 1-3 minutu deskantsatu. Berriz, 10-12 aldiz errepikatu.

Aldaera baten jarraibideak:

Hasierako Posizioa: Zutik, oinak sorbalden zabaleran dituzula, aulki/mahai baten atzean honi soilik esku batekin eutsita jarri oreka mantentzeko.



- Kontzentratu poliki arnasten duzun bitartean.
  Arnas egin eta belauna tolestu gabe poliki hanka atzerantz mugitu. Saiatu aurrerantz ez inklinatzen. Sostengu hanka arinki tolestua egon behar du.
- Posizio horretan segundo 1 iraun. Arnastu poliki hanka hasierako posiziora jaisten duzun bitartean.

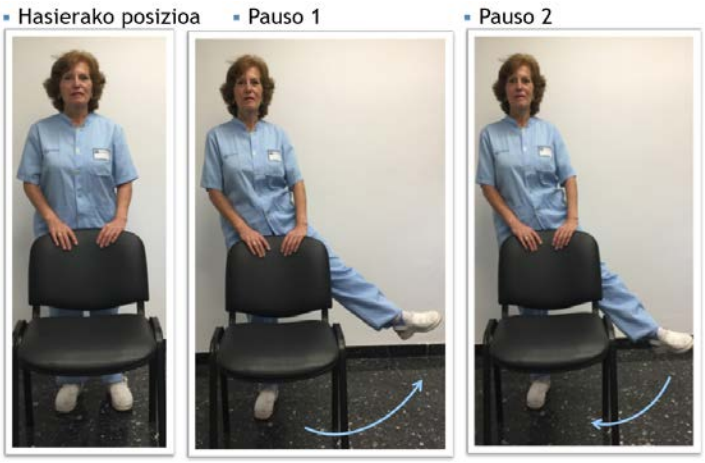
10-12 aldiz errepikatu, hankak tartekatuz. 1-3 minutu deskantsatu. Berriz, 10-12 aldiz errepikatu.

<u>ALDAKA BANATZEA (GLUTEO ERTAINA)</u>

Ariketa honek bi aldakak eta ipurmasailak indartuko dizkizu.

Jarraibideak:

Hasierako Posizioa: Zutik, oinak sorbalden zabaleran dituzula, aulki/mahai baten atzean honi eutsita jarri oreka mantentzeko.

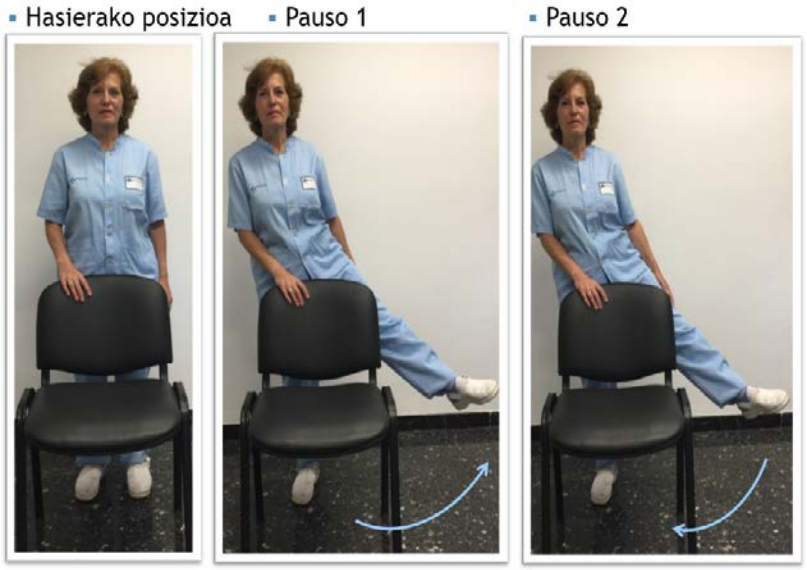


- Kontzentratu poliki arnasten duzun bitartean.
  Arnas egin eta belauna tolestu gabe poliki hanka alborantz mugitu. Saiatu bizkarra zuzen mantentzen eta ez inklinatzen. Sostengu hanka luzatuta egon behar du.
- Posizio horretan segundo 1 iraun. Arnastu poliki hanka hasierako posiziora jaisten duzun bitartean.

10-12 aldiz errepikatu, hankak tartekatuz. 1-3 minutu deskantsatu. Berriz, 10-12 aldiz errepikatu.

Aldaera baten jarraibideak:

Hasierako Posizioa: Zutik, oinak sorbalden zabaleran dituzula, aulki/mahai baten atzean honi soilik esku batekin eutsita jarri oreka mantentzeko.



- Kontzentratu poliki arnasten duzun bitartean.

  Arnas egin eta belauna tolestu gabe poliki hanka alborantz mugitu. Saiatu bizkarra zuzen mantentzen eta ez inklinatzen. Sostengu hanka luzatuta egon behar du.

- Posizio horretan segundo 1 iraun. Arnastu poliki hanka hasierako posiziora jaisten duzun bitartean.

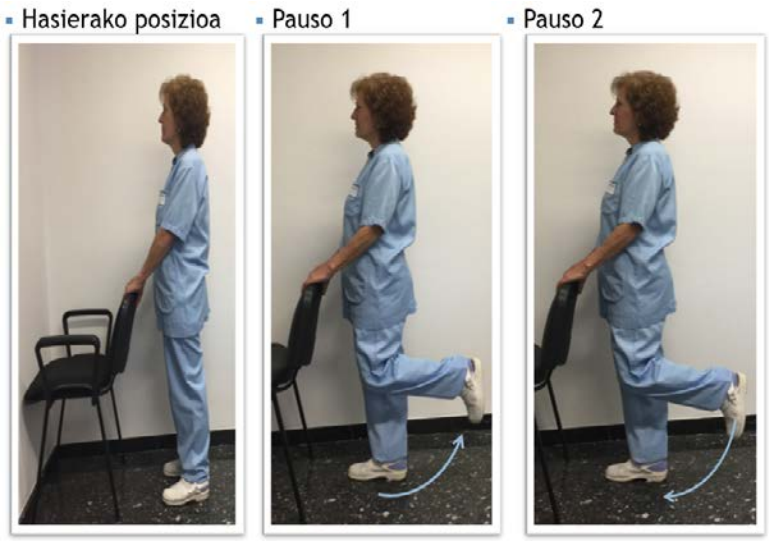
  10-12 aldiz errepikatu, hankak tartekatuz. 1-3 minutu deskantsatu. Berriz, 10-12 aldiz errepikatu.

<u>BELAUN TOLESTEA (ISKIOTIBIALA)</u>

Ariketa honek izter atzealdea indartuko dizu aldakaren luzaketa eta belaun tolestea erraztuz.

Jarraibideak:

Hasierako Posizioa: Zutik, oinak sorbalden zabaleran, aulki/mahai baten atzean honi eutsita jarri oreka mantentzeko.



- Kontzentratu poliki arnastuz.
  Arnas egin eta belauna tolestu oina lurretik altxatuz. Saiatu bizkarra zuzen mantentzen eta ez inklinatzen. Sostengu hanka luzatuta egon behar du.

- Posizio hori 2-3 segundoz mantendu. Arnastu poliki hanka (belauna luzatu) hasierako posiziora jaisten duzun bitartean.

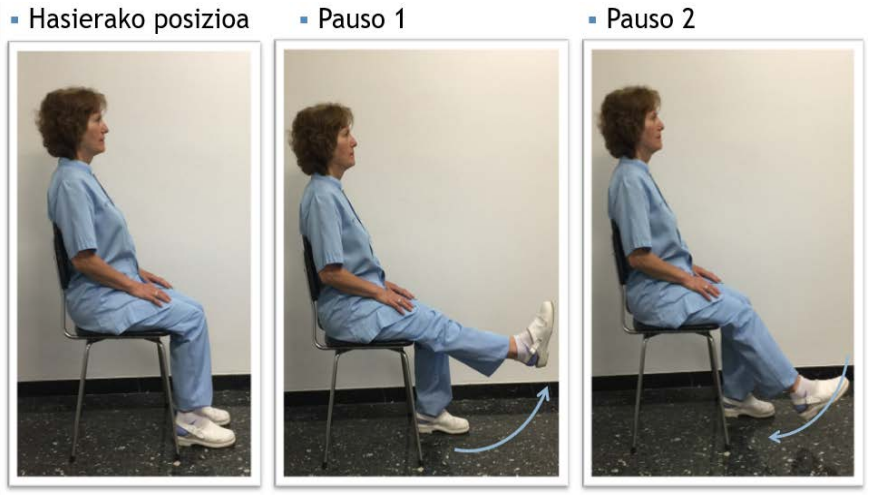
10-12 aldiz errepikatu, hankak tartekatuz. 1-3 minutu deskantsatu. Berriz, 10-12 aldiz errepikatu.

BELAUN LUZATZEA (KOADRIZEPS)

Ariketa honek izterrak indartu eta belauneko artritis sintomak murriztu ditzake.

Jarraibideak:

Hasierako Posizioa: Aulki egonkor batean eseri oinak lurrean sorbalden zabaleran jarrita dituzula. Eskuak izter gainean eta bizkarraldea guztiz bermatua zein luzatua jarri.



- Kontzentratu poliki arnastuz.
  Arnas egin eta belauna guztiz luzatu (izterra igo gabe) oina lurretik altxatuz baina belauna blokeatu gabe.
- Posizio hori 2-3 segundoz mantendu. Arnastu poliki hanka (belauna tolestu) hasierako posiziora jaisten duzun bitartean.

10-12 aldiz errepikatu, hankak tartekatuz. 1-3 minutu deskantsatu. Berriz, 10-12 aldiz errepikatu.

HANKAK ETA KOREA

Ariketa honek, abdomena, izterrak, aldaka eta gluteoa indartuko dizkizu.

Jarraibideak:

Hasierako Posizioa: Oinak lurrean sorbalden zabaleran jarririk beso-euskarridun aulki erresistente batean eseri. Bizkarra zein sorbaldak zuzen mantenduz pixka bat aurreraka inklinatu zaitez. Beso-euskarriak eskuekin eutsi, eta lasai arnastu ezazu.

- Arnasa eginez erabili besoak zure gorputza aulkitik urrundu eta zutik jarri ahal izateko. Zutik eta tente segundo 1 mantendu zaitez.
- Arnastu beso-euskarriak eutsita poliki hasierako posiziora itzultzen zaren bitartean.

10-12 aldiz errepikatu. 1-3 minutu deskantsatu. Berriz, 10-12 aldiz errepikatu.

Aldaera baten jarraibideak:

Hasierako Posizioa: Oinak lurrean sorbalden zabaleran jarririk beso-euskarridun aulki erresistente batean eseri. Bizkarra zein sorbaldak zuzen mantenduz pixka bat aurreraka inklinatu zaitez. Beso-euskarri batean esku bat jarri eta bestea zure alboan, lasai arnastu ezazu.

▪ Hasierako posizioa ▪Pauso 1 ▪ Pauso 2

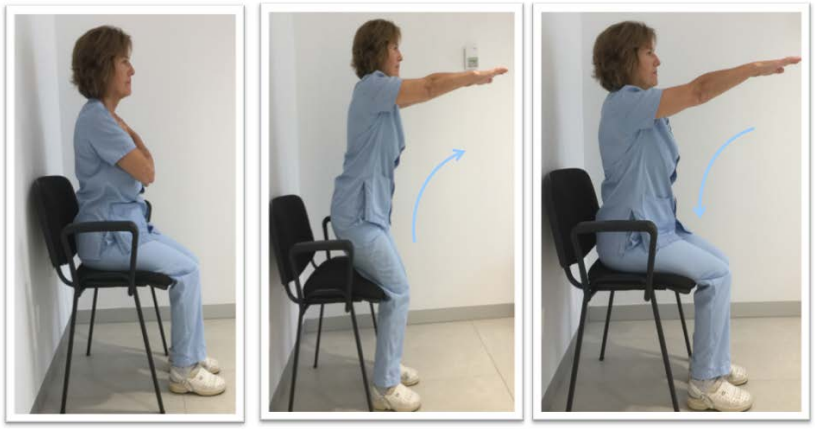
- Arnasa eginez erabili besoa zure gorputza aulkitik urrundu eta zutik jarri ahal izateko. Zutik eta tente segundo 1 mantendu zaitez.
- Arnastu beso-euskarrira eutsita poliki hasierako posiziora itzultzen zaren bitartean.

10-12 aldiz errepikatu. 1-3 minutu deskantsatu. Berriz, 10-12 aldiz errepikatu.

Bigarren aldaeraren jarraibideak:

Hasierako Posizioa: Oinak lurrean sorbalden zabaleran jarririk aulki erresistente batean eseri. Bizkarra zein sorbaldak zuzen mantenduz besoak bularrean gurutzatu.

▪ Hasierako Posizioa ▪ Pauso 1 ▪ Pauso 2

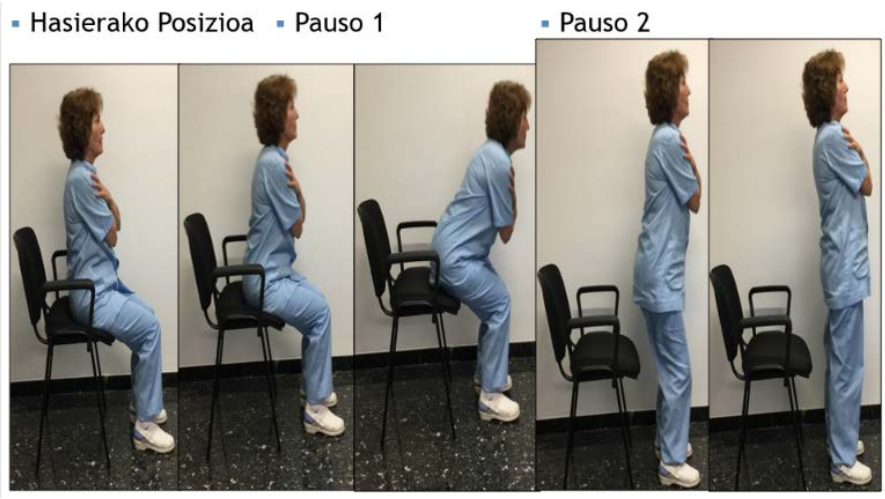


- Arnasa eginez enborra aurreraka inklinatu. Besoa luzatuz (lurrarekiko paralelo jarri) eta mugimendu horren inertzia erabiliz zure gorputza aulkitik urrundu eta altxatu. Zutik eta tente segundo 1 mantendu zaitez.
- Arnastu ezazu poliki hasierako posiziora itzultzen zaren bitartean. Besoak luzatuak mantendu bukaeran berriz gurutzatzeko.

10-12 aldiz errepikatu. 1-3 minutu deskantsatu. Berriz, 10-12 aldiz errepikatu

Hirugarren aldaeraren jarraibideak:

Hasierako Posizioa: Oinak lurrean sorbalden zabaleran jarririk aulki erresistente baten ertzean eseri. Bizkarra zein sorbaldak zuzen mantenduaz besoak bularrean gurutzatu.



- Arnasa eginez enborra aurreraka inklinatu. Belaunak luzatuz eta mugimendu horren inertzia erabiliz zure gorputza aulkitik urrundu eta altxatu. Zutik eta tente segundo 1 mantendu zaitez.
- Arnastu ezazu lasai, poliki hasierako posiziora itzultzen zaren bitartean besoak bularrean gurutzatuak dituzula.

10-12 aldiz errepikatu. 1-3 minutu deskantsatu. Berriz, 10-12 aldiz errepikatu

ADUKTOREAK ETA ABDUKTOREAK

Ariketa honek izterrak indartu eta urratsean zehar oreka zein egonkortasun ona izaten lagunduko dizu.

Jarraibideak:

Hasierako Posizioa: Aulki egonkor batean eseri, oinak lurrean sorbalden zabaleran jarri, baloia belaunarekin eutsiz. Eskuak izter gainean eta bizkarraldea guztiz bermatua zein luzatua jarri.

- Kontzentratu poliki arnasten duzun bitartean.

  Arnas egin eta baloia ahal duzun guztia estutu. Egoera horretan 2-3 segundoz iraun .
- Hasierako posiziora itzultzeko lasaitasunez arnastu hankak irekitzen dituzun bitartean.

10-12 aldiz errepikatu. 1-3 minutu deskantsatu. Berriz, 10-12 aldiz errepikatu

ADUKTOREAK ETA ABDUKTOREAK

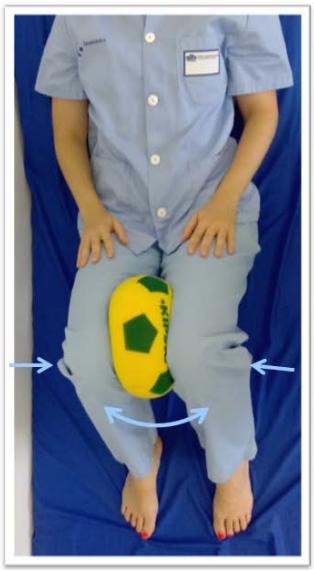
Ariketa honek izterrak indartu eta urratsean zehar oreka zein egonkortasun ona izaten lagunduko dizu.

Jarraibideak:

Hasierako Posizioa: Ohean ahoz gora etzan, belaunak tolestuak eta oinak sorbalden zabaleran baloia eusten dituzula jarri. Eskuak izter gainean eta bizkarraldea guztiz bermatua zein luzatua jarri.

▪ Hasierako Posizioa

▪ Pauso 1



- Kontzentratu poliki arnasten duzun bitartean.

  Arnas egin eta baloia ahal duzun guztia estutu. Egoera horretan 2-3 segundoz iraun .

- Hasierako posiziora itzultzeko lasaitasunez arnastu hankak irekitzen dituzun bitartean.

10-12 aldiz errepikatu. 1-3 minutu deskantsatu. Berriz, 10-12 aldiz errepikatu.

OREKA

OINAK JUNTU

Ariketa hau bi eskuren edo bakarraren bermearekin egin daiteke edota sostengu gabe. Baita ere begiak irekita edo itxita egitearen aldaera sar genezake.

Jarraibideak:

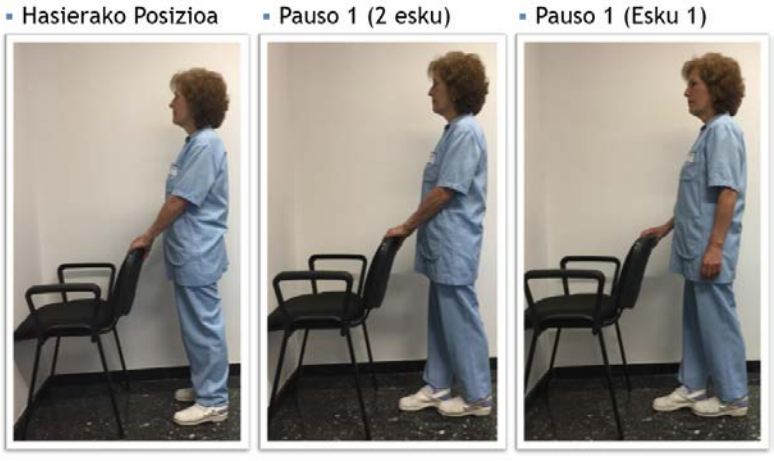
- Hasierako Posizioa: Zutik, oinak sorbalden zabaleran dituzula, aulki/mahai baten atzean honi eutsita jarri oreka mantentzeko.
- Pauso 1: Prest sentitzen zarenean bi oinak elkartu, itsatsita egongo balira bezala. Posizio hori 10-12 segundoz mantendu. Gerora hasierako posiziora itzuli.

Fase guzti hau 3 aldiz errepikatu. Oso garrantzitsua ariketa guztiz zentratua eta kontzentratua zaudela gauzatzea.

"SEMI-TÁNDEM"

Ariketa hau bi eskuren edo bakarraren bermearekin egin daiteke edota sostengu gabe. Baita ere begiak irekita edo itxita egitearen aldaera sar genezake.

Jarraibideak:



- Hasierako Posizioa: Zutik, oinak sorbalden zabaleran dituzula, aulki/mahai baten atzean honi eutsita jarri oreka mantentzeko.
- Pauso 1: Prest sentitzen zarenean bi oinak elkartu, bat bestea baino pixka bat aurreratuago jarriz. Alegia, aurrerago ezarririko oinaren orpoa, beste oinaren behatz lodiaren parean jarri. Posizio hori 10-12 segundoz mantendu. Gerora hasierako posiziora itzuli.

Fase guzti hau 3 aldiz errepikatu. Oso garrantzitsua ariketa guztiz zentratua eta kontzentratua zaudela gauzatzea.

“TÁNDEM”

Ariketa hau bi eskuren edo bakarraren bermearekin egin daiteke edota sostengu gabe. Baita ere begiak irekita edo itxita egitearen aldaera sar genezake.

Jarraibideak:

- Hasierako Posizioa: Zutik, oinak sorbalden zabaleran dituzula, aulki/mahai baten atzean honi eutsita jarri oreka mantentzeko.
- Pauso 1: Prest sentitzen zarenean bi oinak elkartu, bat bestearen aurrean jarriz, alegia, ilaran egongo balira bezala.

  Posizio hori 10-12 segundoz mantendu. Gerora hasierako posiziora itzuli.

Fase guzti hau 3 aldiz errepikatu. Oso garrantzitsua ariketa guztiz zentratua eta kontzentratua zaudela gauzatzea.

“MONOPODAL”

Ariketa hau bi eskuren edo bakarraren bermearekin egin daiteke edota sostengu gabe. Baita ere begiak irekita edo itxita egitearen aldaera sar genezake.

Jarraibideak:

- Hasierako Posizioa: Zutik, oinak sorbalden zabaleran dituzula, aulki/mahai baten atzean honi eutsita jarri oreka mantentzeko.
- Paso 1: Prest sentitzen zarenean lurretik oin bat altxatu ezazu. Oina gorputzaren aurrealdetik edo atzealdetik altxa dezakezu.

  Posizio hori 10-12 segundoz mantendu. Gerora hasierako posiziora itzuli.

Fase guzti hau 3 aldiz errepikatu. Oso garrantzitsua ariketa guztiz zentratua eta kontzentratua zaudela gauzatzea.

ATAL AEROBIKOA

Jarraibide orokorrak:

- Oinez ibiltzea da emango dizugun gomendiorik onena.
- Ahal duzun heinean, egunero oinez ibili, eta saiatu pixkanaka ibilbidea luzatzen.
- Betiere erortzeko arriskuak oso eskasak edo ez daudenean ibiltzea gomendatzen da.
- Laguntza teknikoak erabili: bastoi, muleta, taka-taka eta abar beharrezkoa den heinean soilik.
- Aurrera begira ibil zaitez oinez, ez joan lurrera begira. Ibiltzerakoan sorbaldak erlaxatuak eta besoak arinki kulunkaka dituzula joan.
- Gehiegi nekatzen zarela sentituz gero, eseri eta hartu atseden.

Distantzia ezberdineko Jarraibideak:

- Altxatu eta Ibili (Distantzi Laburrak)

  Aulkitik laguntzarekin edo laguntzarik gabe altxatu, nekeak uzten dizun haina ibili, zutik segundo batzuk deskantsatu (10-15) eta aulkira itzul zaitez.

  5 aldiz errepikatu. Errepikapenen artean minutu 1 deskantsatu.

- Paseoak (Distantzi Luzeak)

  Etxetik atera aurretik gauzatuko duzun ibilbidea distantziaren arabera aukeratu, alegia, gauzatzeak eramango dizun denbora eta ibilbidean zehar deskantsatzeko aukera izango zenuen edo ez kontuan izanik.

  Ordu-erdiko (30') paseoekin hastea gomendatzen dizugu. Hamabosgarren minutuan (15') 30"-1'ko deskantsua egin eta jarraian ibilbideari berriz ekin.

  Oinez erritmo arruntean, zuretzako ohikoa den erritmoan, ibili eta progresiboki iraupena 10-15 minututan igotzen joan. Hau da:

  - 15 minutu (') oinez + 30segundo (") deskantsu + 15 minutu (') oinez
  - 15' oinez + 30-60'' deskantsu + 15' oinez + 30-60'' deskantsu + 15'' oinez
  - 15' oinez + 30-60'' deskantsu + 15' oinez + 30-60'' deskantsu + 15' oinez + 30-60'' deskantsu +15' oinez.

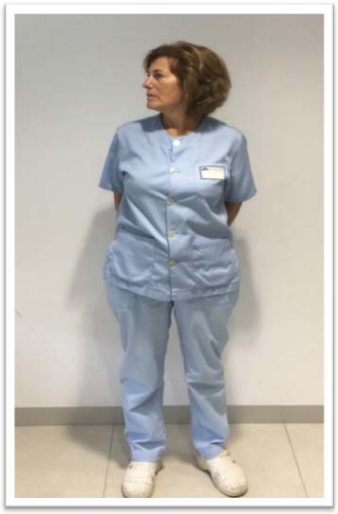
MALGUTASUNA

LEPO ETA ZERBIKALAK

Luzaketa erraz honek lepoko zein zerbikaletako tentsioa arintzeko balio dezake. Luzaketa hau eserita zein zutik gauzatu dezakezu.

Jarraibideak:

▪ Pauso 1



▪ Pauso 2

Hasierako Posizioa: Zutik edo eserita, oinak sorbalden zabaleran dituzula jar zaitez.

- Arnasa egin eta poliki burua eskuinerantz bihurtu luzatze arin bat nabaritu arte. Tentuz ibili lepoa ez aurrera ez atzera inklinatzeko, posizio eroso batean egon behar zara. Arnastu eta 3-5 segundoz posizioa mantendu ezazu.
- Arnas egin eta oraingoa burua beste alderantz (ezkerra) bihurtu.

Albo bakoitzera 4 aldiz errepikatu.

GERRI ETA BIZKAR

Luzaketa erraz honek zure bizkar zein sorbaldetako tentsioa arintzeko balio dezake. Luzaketa hau eserita zein zutik gauzatu dezakezu.

Jarraibideak:

Hasierako Posizioa: Zutik edo eserita, oinak sorbalden zabaleran dituzula jar zaitez.

▪ Hasierako Posizioa

▪ Pauso 1

▪ Pauso 2

- Arnasa egin eta poliki gerria eskuinerantz biratu luzatze arin bat nabaritu arte. Tentuz ibili goi enborra ez aurrera ez atzera inklinatzeko, posizio eroso batean egon behar zara. Arnastu eta 3-5 segundoz posizioa mantendu ezazu.
- Arnas egin eta oraingoa burua beste alderantz (ezkerra) biratu. Eskuen kokapenean jar ezazu arreta.

Albo bakoitzera 4 aldiz errepikatu.

SORBALDAK

Luzaketa erraz honek zure sorbalden eta bizkarreko goi atalaren tentsioa arintzeko balio dezake. Luzaketa hau eserita zein zutik gauzatu dezakezu.

Jarraibideak:

Hasierako Posizioa: Zutik edo eserita, oinak sorbalden zabaleran eta besoak gurutze eran dituzula jar zaitez.

▪ Pauso 1

▪ Pauso 2

- Besoak gurutze eran eta esku-ahurrak aurrerantz begira, sorbalden altueran mantendu itzazu.
- Poliki arnas egin eta besoak atzerantz bihurtu omoplatoak estutzen (hurbiltzen) dituzun bitartean.

Luzatze edo egonezin arin bat nabaritzerakoan gelditu. Arnastu eta 3-5 segundoz posizioa mantendu ezazu. 4 aldiz errepikatu.

Aldaera baten jarraibideak:

Hasierako Posizioa: Zutik edo eserita, oinak sorbalden zabaleran eta besoak gurutze eran dituzula jar zaitez.

▪ Pauso 1

▪ Pauso 2

- Besoak gurutze eran eta esku-ahurrak aurrerantz begira, sorbalden altueran mantendu itzazu.
- Poliki arnas egin eta besoak gorantz bihurtu omoplatoak estutzen (hurbiltzen) dituzun bitartean. Luzatze edo egonezin arin bat nabaritzerakoan gelditu. Arnastu eta 3-5 segundoz posizioa mantendu ezazu.

4 aldiz errepikatu.

IZTER ATZEALDEA

Luzaketa erraz honek zure izterren atzealde zein bikietako tentsioa arintzeko balio dezake. Luzaketa hau eserita zein zutik gauzatu dezakezu.

Jarraibideak:

Hasierako Posizioa: Aulki erresistente baten ertzean eseri, hanka bat guztiz luzaturik eta bestea 90º tolesturik duzula.

- Pauso 1

- Pauso 2

- Hasierako posizioan egonik, luzaturiko hankaren orpoa lurrean bermatu (oin punta gorantz begira dagoelarik) pilota hanka bereko izterrean jartzen duzun bitartean. Birikak haizez bete.
- Arnas egin hankan zehar pilota poliki jaisten duzun bitartean. Luzatze edo egonezin arin bat nabaritzerakoan gelditu. Arnastu eta 3-5 segundoz posizioa mantendu ezazu. Hanka bakoitzarekin 4 aldiz errepikatu.

6. ERANSKINA:

Balorazio eta erregistro orriak

6. APPENDIX:

Valuation and recording sheets

Data: Izena:

Hospitalizazioa

DINAMOMETRIA				
Ezkerra	L1	kg	L2	kg
Eskuina	R1	kg	R2	kg

DATU ANTROPOMETRIKOAK	
Pisua (Kg)	
Altuera(cm)	
Bernaren diametroa	
IMC: Pisua / Altuera^2	

G ♂	(2,02 x belaunaren altuera) - (0,04 x adina) + 64,19
E ♀	(1,83 x belaunaren altuera) - (0,24 x adina) + 84,88

SPPB		Denbora		Puntuak
Altxa-eseri (5 errep) (sg)				
Oreka oinak elkarrekin (10s)				
Oreka Semitandem (10s)				
Oreka Tandem (10s)				
Materiala:	Martxa 4m			
		GUZTIRA		

PFEIFFER

INSTRUCCIONES: Preguntar las cuestiones 1-10 en este orden y recoger todas las respuestas. Recoger el número total de errores	**Errores**
¿Cuál es la fecha de hoy? (día, mes, y año)	
¿Qué día de la semana es hoy?	
¿Cuál es el nombre de este sitio? (vale cualquier descripción correcta del lugar)	
¿Cuál es su número de teléfono? (Si no tiene, ¿cuál es su dirección completa?)	
¿Qué edad tiene?	
Dígame su fecha de nacimiento	
¿Cómo se llama el Presidente del Gobierno?	
¿Cómo se llama el anterior Presidente del Gobierno?	
Dígame el primer apellido de su madre	
Reste de tres en tres desde 20. (cualquier error hace errónea la respuesta)	
TOTAL	

Valoración:
0-2 errores: normal
3-4 errores: deterioro leve
5-7 errores: deterioro moderado
8-10 errores: deterioro severo/grave

- Si el nivel educativo es bajo (estudios elementales) se admite 1 error más por cada categoría.
- Si el nivel educativo es alto (estudios universitarios) se admite un error menos.

MNA-SF

	A. Ha perdido el apetito? Ha comido menos por falta de apetito, problemas digestivos, dificultades de masticación o deglución en los últimos 3 meses?		
	0 = ha comido mucho menos		
	1 = ha comido menos		
	2 = ha comido igual		
	B. Pérdida reciente de peso (<3 meses)		C. Movilidad
	0 = pérdida de peso > 3 kg		0= de la cama al sillón
	1= no lo sabe		1= autonomía en el interior
	2= pérdida de peso entre 1 y 3 kg		2= sale del domicilio
	3 = no ha habido pérdida de peso		
	D. Ha tenido una enfermedad aguda o situación de estrés psicológico en los últimos 3 meses?		
	0=SI // 1=no		
	E. Problemas Neuropsicológicos		
	0= Demencia o depresión severa		
	1= Demencia o depresión moderada		
	2= Sin problemas psicológicos		
	F1. Índice de Masa Corporal (IMC: Peso / Talla²)	F2. Circunferencia de la pantorrilla (cm)	
	0= IMC < 19	0= CP < 31	Cm:
	1= IMC 19-21	3= CP ≥ 31	
	2= IMC 21-23	(sino IMC sustituir F1 por F2)	
	3= IMC ≥ 23	No contestar F2 si se ha podido contestar F1	

FRIED

	Pérdida de peso involuntario Ha perdido más de 4.5kg en el último año de forma involuntaria?	NO		SI	
	Estado de ánimo decaído. En la última semana:	Raramente (<1día)	Pocas veces (1-2 días)	Ocasionalmente (3-4 días)	La mayor parte del tiempo (5-7 días)
	¿Cuántos días ha sentido que todo lo que hacía era un esfuerzo?				
	¿Cuántas veces no ha tenido ganas de hacer nada?				
	Velocidad de la marcha Según altura y peso ¿El paciente tarda igual o más de lo indicado en caminar en 4m? ♂ ≤173cm ---------- ≥ 6.1s (0.66m/s) >173cm ---------- ≥ 5.2s (0.77m/s) ♀ ≤159cm ---------- ≥ 6.1 s (0.66 m/s) >159cm --------- ≥ 5.2 s (0.77 m/s)	NO		SI	
	Actividad Física Realiza semanalmente ≤ de la actividad física indicada ♂ <383 kcal/sem (pasear ≤ 2¨30h/sem) ♀ <270 kcal/sem (pasear ≤ 2h/sem)	NO		SI	
	Debilidad muscular Según IMC y sexo ¿la fuerza prensora de la menor es ≤ a la indicada?	NO		SI	

IMC ♂	*DIM*		*IMC ♀*	*DIM*		*TOTAL:*
<24	*≤20kg*		*<23*	*≤17kg*		
24.1-26	*≤30 kg*		*23.1-26*	*≤17.3kg*		*≥3: frágil*
26.1-28	*≤30kg*		*26.1-29*	*≤18kg*		*1-2: prefrágil*
>28	*≤32kg*		*>29*	*≤21kg*		*0: robusto*

Data: Izena:

ALTA EGUNA

DINAMOMETRIA			
Ezk1		Ezk2	
Esk1		Esk2	

TEST	1.go Saiakera	2.go Saiakera	Oharrak
1. **TUG**:Altxa, ibili eta eseri **NORMAL** (3m) (sg)			
2. **8FUG**: Altxa, ibili eta eseri **AZKAR** (2,44m) (sg)			

	4m Norm.	8m Norm.	4m Azk.	8m Azk.	Oharrak
3. Ibilera abiadura. 1.proba (sg)					
4. Ibilera abiadura. 2.proba (sg)					

TEST	Errep.
Aulkitik alta eta eseri *(30")*	
Beso flexioa mankuernekin *(30")*	

SPPB	Denbora	Puntuak
Altxa-eseri (5 errep) (sg)		
Oreka olnak elkarrekin (10s)		
Oreka semitandem (10s)		
Oreka tandem (10s)		
Materiala: Martxa 4m		
	GUZTIRA	

Data: Izena:

EGUNA: Lab. 1 Lab.2 Lab. 3 Lab. 4

DINAMOMETRIA				
Ezkerra	Ezk1	Kg	Ezk2	Kg
Eskuina	Esk1	Kg	Esk2	Kg

SENIOR FITNESS TEST (SFT)					
TEST	1.go saiakera		2. saiakera		Oharrak
1. Aulkitik altxa eta eseri(30") *(errep.)*			x		
2. Beso-flexioa mankuernekin *(30") (errep.)*			x		
3. TUG: Altxa, ibili, eseri NORMAL 3m (sg)					
4. 8FUG: Altxa, ibili eta eseri AZKAR (2,44m) (sg)					
	4m Norm.	8m Norm.	4m Azk.	8m Azk.	
5. Ibilera abiadura 1. Proba (sg)					
6. Ibilera abiadura 2.Proba (sg)					

6MWT		
Joan/Etorri (30m) Bira osoa (60m)		Denbora
1	60m	
2	120m	
3	180m	
4	240m	
5	300m	
6	360m	
7	420m	
8	480m	
9	540m	
10	600m	
11	660m	
12	720m	
13	780m	
14	840m	
15	900m	
16	960m	
BUELTAK GUZTIRA (m)		
DISTANTZIA (m)		
GUZTIRA (m)		

Berg oreka testa	Puntuazioa
1. Aulkitik altxa	
2. Zutik egon	
3. Eserita egon	
4. Aulkian Eseri	
5. Transferentziak	
6. Begiak itxita	
7. Oinak elkartuta	
8. Besoa aurreraka luzatu	
9. Lurretik objektu bat jaso	
10. Atzera begiratu	
11. 360°-ko bira ematea	
12. Oinak step edo eskaloi baten gainean jarri	
13. Tandem	
14. Hanka bakarrean	
GUZTIRA	

Pisua	kg	
	Ezkerra	Eskuina
Altuera (cm)		

		Oharrak	Borg
Bm Hasierakoa			Arnasketa: 1 2
Bm amaierakoa			Hankak: 1 2
Bm Errek (1')			

SPPB		Denbora		Puntuak
Altxa-eseri (5 errep) (sg)				
Oreka oinak elkarrekin (10s)				
Oreka semitandem (10s)				
Oreka tandem (10s)				
Materiala:	Martxa 4m			
		GUZTIRA		

7. ERANSKINA:

Azelerometroen informazio zein erregistro orriak

7. APPENDIX:

Accelerometer information and recording sheets

ACELERÓMETRO: HOJA INFORMATIVA

Estimado señor o señora:

Antes que nada, gracias por haberse animado a participar en nuestro estudio. En este estudio el objetivo, entre otros, es determinar el nivel de actividad física de las personas mayores de 70 años. Un acelerómetro nos permite recoger y memorizar todos los movimientos de su cuerpo. Para ello, necesitamos que usted lleve puesto los acelerómetros durante nueve días.

¿Cuándo debo ponerme el ACELERÓMETRO?

- Quisiéramos que usted lleve puesto el acelerómetro durante 9 días.
- Para ello, va a empezar a ponerse este dispositivo el primer día de las pruebas en el Hospital Universitario de Araba (Santiago) y llevarlo durante 9 días.
- Acuérdese de ponerse los acelerómetros TODOS LOS DÍAS DE LA SEMANA (incluidos los sábados y domingos).
- Los acelerómetros están programados para que comience a recoger datos y para que termine de hacerlo. USTED NO TIENE QUE HACER NADA PARA ENCENDERLO O APAGARLO.
- Por favor, póngase el acelerómetro continuamente (desde que se despierta por la mañana hasta que se acuesta por la noche).
- QUÍTESE EL DE LA CADERA/CINTURA PARA: DORMIR, NADAR, DUCHARSE.
- QUÍTESE EL DE LA MUÑECA SOLO PARA: NADAR o DUCHARSE.

¿Cómo debo usar el ACELERÓMETRO?

- Asegúrese de que se pone el acelerómetro de la cadera tan pronto como se levante de la cama.
- Retírese el acelerómetro de la cadera cuando se acueste para dormir la siesta en cama o cuando se acueste a la noche.
- CINTURA: El acelerómetro tiene un cinturón de goma para que se lo ponga alrededor de la cintura. EL ACELERÓMETRO DEBE IR PUESTO ALREDEDOR DE SU CINTURA Y SITUADO EN SU LADO DERECHO CON EL BOTÓN NEGRO HACIA ARRIBA (ver foto1).
- MUÑECA: El acelerómetro tiene una pulsera para que se lo ponga alrededor de la muñeca. EL ACELERÓMETRO DEBE IR PUESTO ALREDEDOR DE SU MUÑECA NO-DOMINANTE Y CUANDO LO MIRE EL LOGOTIPO DE ACTIGRAPH TIENE QUE ESTAR HACIA ARRIBA (ver foto 2).
- Es importante que el cinturón o la muñequera estén ajustados adecuadamente de tal forma que no le oprima pero que no esté demasiado flojo.
- No importa si se lo coloca debajo o encima de la ropa.

Por favor, retire el acelerómetro SOLAMENTE:

- LOS DOS: Cuando se va a bañar, al ducharse o al nadar en la piscina
- SOLO EL DE LA CINTURA: Cuando se acuesta para dormir la siesta en la cama o cuando se acuesta a la noche.

Foto 2: ejemplo de muñeca

Foto 1

AZELEROMETROA: INFORMAZIO ORRIALDEA

Jaun/andre agurgarria:

Lehenik eta behin, eskerrik asko geure ikerketan parte hartzera animatu izateagatik. Badakizunez, ikerketaren helburua 70 urte baino gehiagoko pertsonengan jarduera fisikoaren mailak aztertzea da, beste parametro batzuen artean. Azelerometro batek gorputzaren mugimenduak jaso eta memorizatzea ahalbidetzen digu. Horretarako, zeuk aste batean zehar azelerometroa soinean eramatea behar dugu. Hortaz, zeure parte hartzea ikerketan ezinbestekoa da.

AZELEROMETROA noiz ipini behar dut?

- 9 egunetan zehar azelerometroa soinean eramatean nahiko genuke.
- Horretarako, Arabako Unibertsitate Ospitalean (Santiago) probak egindako lehenengo egunean, aparatu hau ipinita eramaten hasiko zara eta 9 egunez eraman beharko duzu.
- EGUN GUZTIETAN gogoratu azelerometroa ipintzeaz.
- Azelerometroa programatuta dago datuak jasotzen hasi eta amaitzeko. ZUK EZ DUZU EZER EGIN BEHAR PIZTEKO EDO ITZALTZEKO.
- Mesedez, azelerometroa etengabean ipinita eraman (goizean esnatzen zarenetik gauean oheratzen zaren arte).
- LO EGITEKO, IGERI EGITEKO ETA DUTXA HARTZEKO KENDU EZAZU BAKARRIK ALDAKA/GERRIKO AZELEROMETROA.
- IGERI EGITEKO ETA DUTXA HARTZEKO KENDU EZAZU BAKARRIK ESKUMUTURREKO AZELEROMETROA.

Nola erabili behar dut AZELEROMETROA?

- Ziurtatu zaitez ohetik jaiki bezain laster aldakako azelerometroa ipintzeaz.
- Kendu ezazu aldakako azelerometroa lo-kuluxka egiteko edo gauean oheratzeko.
- GERRIA: Azelerometroak gomazko gerrikoa dauka gerriaren inguruan ipintzeko (ikusi 1. go argazkia). AZELEROMETROA GERRIAREN INGURUAN IPINI BEHAR DUZU ETA ESKUINEKO ALDEAN KOKATU BOTOI BELTZA GORANTZ JARRIZ.
- ESKUMUTURRA: Azelerometroa zinta itsaskor baten bitartez lotzeko prestatua dago. AZELEROMETROA ESKUMUTUR EZ DOMINANTEAREN INGURUAN JARRI BEHAR DA ETA HAU BEGIRATZEAN ACTIGRAPH LOGOTIPOA GORANTZ BEGIRA GERATU BEHAR DA (Ikusi 2. irudia).
- Gerrikoa modu egokian estutzea garrantzitsua da, ez estuegi ezta askeegi ere.
- Azelerometroa arroparen gainean edo azpian jar daiteke.

AZELEROMETROA kasu hauetan bakarrik kendu:

- Bainatu, dutxatu edo igerilekuan sartuko zarenean.
- Lo-kuluxka egingo duzunean edo gauean oheratzerakoan

2.Irudia: eskuineko eskumuturra adb

1.Irudia

DATA	ESNATU Gerrikoa jarri	DUTXA Gerrikoa eta erlojua	LOKULUXKA Gerrikoa	OHERATU Gerrikoa kendu
Adibidea:15/5/2018 Asteartea	Jarri: 9.00 H	Kendu: 10.15 H Jarri: 10.30 H	Kendu: 15.15 H Jarri: 16.00 H	Kendu: 23.00 H
1.Eguna	Jarri:	Kendu: Jarri:	Kendu: Jarri:	Jarri:
2.Eguna	Jarri:	Kendu: Jarri:	Kendu: Jarri:	Jarri:
3.Eguna	Jarri:	Kendu: Jarri:	Kendu: Jarri:	Jarri:
4.Eguna	Jarri:	Kendu: Jarri:	Kendu: Jarri:	Jarri:
5.Eguna	Jarri:	Kendu: Jarri:	Kendu: Jarri:	Jarri:
6.Eguna	Jarri:	Kendu: Jarri:	Kendu: Jarri:	Kendu:
7.Eguna	Jarri:	Kendu: Jarri:	Kendu: Jarri:	Kendu:
8.Eguna	Jarri:	Kendu: Jarri:	Kendu: Jarri:	Kendu:

GERRIKOA KENDU LO EGITEKO eta **DUTXATZEKO**

ERLOJUA KENDU DUTXATZEKO

EZ BUSTI!

HUA Santiago. 3ªSolairua – B Pabiloia, 15. Kontsulta. Tlf.: 945 00 77 28

JARRI: **KENDU:**

HURRENGO HITZORDUA:

ORDUA:

8. ERANSKINA:

Bizikalitatea galdetegia: EuroQol 5D-5L

8. APPENDIX:

Quality of Life questionnaire: EuroQol 5D-5L

Debajo de cada enunciado, marque UNA casilla, la que mejor describe su salud

MOVILIDAD

No tengo problemas para caminar ❑
Tengo problemas leves para caminar ❑
Tengo problemas moderados para caminar ❑
Tengo problemas graves para caminar ❑
No puedo caminar ❑

AUTO-CUIDADO

No tengo problemas para lavarme o vestirme ❑
Tengo problemas leves para lavarme o vestirme ❑
Tengo problemas moderados para lavarme o vestirme ❑
Tengo problemas graves para lavarme o vestirme ❑
No puedo lavarme o vestirme ❑

ACTIVIDADES COTIDIANAS *(Ej.: trabajar, estudiar, hacer las tareas domésticas, actividades familiares o actividades durante el tiempo libre)*

No tengo problemas para realizar mis actividades cotidianas ❑
Tengo problemas leves para realizar mis actividades cotidianas ❑
Tengo problemas moderados para realizar mis actividades cotidianas ❑
Tengo problemas graves para realizar mis actividades cotidianas ❑
No puedo realizar mis actividades cotidianas ❑

DOLOR / MALESTAR

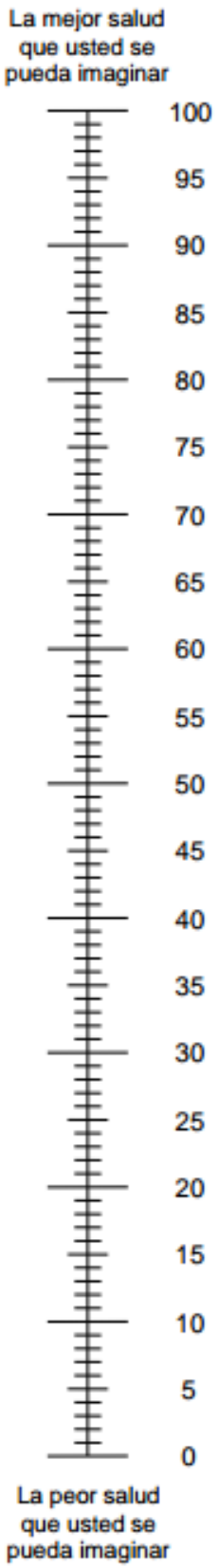
No tengo dolor ni malestar ❑
Tengo dolor o malestar leve ❑
Tengo dolor o malestar moderado ❑
Tengo dolor o malestar fuerte ❑
Tengo dolor o malestar extremo ❑

ANSIEDAD / DEPRESIÓN

No estoy ansioso ni deprimido ❑
Estoy levemente ansioso o deprimido ❑
Estoy moderadamente ansioso o deprimido ❑
Estoy muy ansioso o deprimido ❑
Estoy extremadamente ansioso o deprimido ❑

- Nos gustaría conocer lo buena o mala que es su salud HOY.
- La escala está numerada del 0 al 100.
- 100 representa la mejor salud que usted se pueda imaginar.
  0 representa la peor salud que usted se pueda imaginar.
- Marque con una X en la escala para indicar cuál es su estado de salud HOY.
- Ahora, en la casilla que encontrará a continuación escriba el número que ha marcado en la escala.

SU SALUD HOY = ☐



9. ERANSKINA:

Bordeleko egonaldian zehar parte-harturiko artikulua

9. APPENDIX:

Article participated during the stay in Bordeaux

Protein intake, weight loss, dietary intervention, and worsening of quality of life in older patients during chemotherapy for cancer.

Sophie C. Regueme, Iñaki Echeverria, Nicolas Monéger,Jessica Durrieu, Maïté Becerro-Hallard, Sophie Duc, Aurelie Lafargue, Cécile Mertens, Hamid Laksir, Joël Ceccaldi, Sandrine Lavau-Denes, Thierry Dantoine, Jon Irazusta and Isabelle Bourdel-Marchasson.

Received: 25 January 2020; Accepted: 12 May 2020; Published online: 20 May 2020

Supportive Care in Cancer *2020*, 29(2), 687–696; doi: 10.1007/s00520-020-05528-4

Abstract

Decreased health-related quality of life (HRQoL) is common in patients with cancer. We investigated the effects of dietary intervention and baseline nutritional status on worsening of HRQoL in older patients during chemotherapy. In this randomized control trial assessing the effect on mortality of dietary advice to increase dietary intake during chemotherapy, this post hoc analysis included 155 patients with cancer at risk of malnutrition. The effects of dietary intervention, baseline Mini Nutritional Assessment item scores, weight loss, and protein and energy intake before treatment on the worsening of HRQoL (physical functioning, fatigue) and secondary outcomes (Timed Up and Go test, one-leg stance time, depressive symptoms, basic (ADL), or instrumental (IADL) activities of daily living) were analyzed by multinomial regressions. Dietary intervention increased total energy and protein intake but had no effect on any examined outcomes. Worsening of fatigue and ADL was predicted by very low protein intake (< 0.8 g kg−1 day−1) before chemotherapy (OR 3.02, 95% CI 1.22–7.46, p = 0.018 and OR 5.21, 95% CI 1.18–22.73, p = 0.029 respectively). Increase in depressive symptomatology was predicted by 5.0–9.9% weight loss before chemo- therapy (OR 2.68, 95% CI 1.10–6.80, p = 0.038). Nutritional intervention to prevent HRQoL decline during chemotherapy should focus on patients with very low protein intake along with those with weight loss.

KEYWORDS

MNA . Protein intake . Dietary intervention . HRQoL . Older patient . Cancer . Chemotherapy

Introduction

The impairment of patients' health-related quality of life (HRQoL) during and after cancer treatment is a target for supportive care. Fatigue is one of the most frequent symptoms of altered HRQoL associated with cancer cachexia [1]. In older patients with hematological malignancies, fatigue was shown to be related to impairment of several items of the comprehensive gerontological assessment (CGA) [2] and to low G8 scores. The G8 [3] aims to screen patients needing a CGA and consists of eight items: patient age (> 85, 80–85, < 80) and 7 Mini Nutritional Assessment (MNA©) [4]: the questions of appetite, weight loss, mobility, neuropsycholog- ical problems, body mass index, number of medications, and self-rated health.

Previously, we performed a randomized control trial (RCT) to assess the effects of dietary advice to increase energy and protein intake during chemotherapy treatment in patients at risk of malnutrition according to MNA on 1- year mortality. Despite increases in energy and protein in- take in the intervention group, no effect on mortality was shown [5].

Among MNA items, we showed previously in 606 older patients with solid tumors screened to participate in the abovementioned trial that appetite loss, declared decreased intake of protein rich-food, poorer self-reported quality of life, daily intake of 3 or more medications, and calf circumference lower than 31 cm were independent predictors of 1-year mor- tality [6]. It was surprising that appetite for any food or for protein-rich food was both independent powerful predictors of mortality in the MNA-based predictive model, whereas in contrast, weight loss was not. It is recommended to perform a CGA in older patients, and particularly to perform a nutri- tional assessment [7] including MNA prior implementing can- cer treatment.

Decreased dietary intake due to appetite loss can be considered one of the main features of cachexia syn- drome and particularly in cancer cachexia [8] The inten- sities of both fatigue and appetite loss were shown to be particularly important in advanced cancer [9]. In adult patients, anorexia and early satiety were associated with increased fatigue and, although not independently, to impaired physical function [10]. A cross-sectional study showed a correlation between fatigue severity and al- tered nutritional status after a surgery for colorectal cancer [16].

These different results raise questions regarding the rela- tionships between dietary intake and HRQoL in older patient with cancer. The possible effects of the nutritional status be- fore cancer chemotherapy on the evolution of HrQoL have not been described in older people. Particularly, the possibility of modifying HRQoL by changing protein intake should be explored.

The objective of the present post hoc analysis was to inves- tigate the effects of the dietary intervention on HRQoL on one hand and on the other hand the effects of baseline nutritional assessment including declared and measured total or protein intake, inflammation, and weight loss, on worsening of HRQoL, physical performance, and fatigue in older patients undergoing chemotherapy for lymphoma or solid tumors. CGA items were considered secondary outcomes.

Methods

Study design

The study is a post hoc analysis of an RCT designed to test the effects of dietary advice on mortality in older patients with cancer or lymphoma undergoing chemother- apy and at risk of malnutrition (MNA). Full description of the main study design, recruitment, participation, and ran- domization is published elsewhere [5]. The full MNA [4] was administered before inclusion and randomization. The patients were enrolled before the start of chemother- apy. The intervention lasted 3 to 6 months according to the chemotherapy schedules. Patients were monitored for toxicities during 6 months and for mortality during 2 years. At baseline and at the end of the intervention, CGA, 1-day dietary record, and assessment of HRQoL were performed and were considered for this post hoc analysis. CGA was optional in the main RCT. All assess- ments and dietary interviews were performed in the can- cer treatment setting. The Institutional Review Board of South-West France and Overseas French Departments, France, approved the study protocol. The trial was record- ed with ClinicalTrials.gov, number NCT00459589.

Participants

Data were recorded from the 341 participants of the RCT conducted between 2007 and 2012. Informed written consent was obtained from all patients and eligibility criteria were checked. The patients were aged 70 years and over, had lymphoma or carcinoma, and were at risk of malnutrition ($17 \leq MNA \leq 23.5$). Eligible carcinomas were those of the colon, stomach, pancreas and biliary tract, ovary, prostate, bladder, and lung. Lymphoma types were any B-cell lymphoma, any T-lymphoma, and low malignancy lymphomas, such as fol- licular, lymphoplasmacytic, lymphocytic, mantle, MALT, and other marginal zone lymphoma.

Intervention

There were two groups of randomization: usual care (UC) and usual care + nutritional intervention (UCNI). The usual care group received nutritional care routinely used in the

cancer treatment setting. The intervention consisted of six face-to- face interviews conducted during each chemotherapy session with additional phone support when the intervals between sessions were longer than 3 weeks. The advice aimed to achieve intake of 30 kCal/kg body weight/day and 1.2 g pro- tein/kg/day. Training was provided in each cancer setting to a dietitian devoted to the study.

Assessments

Data on weight loss prior to treatment (as a percentage of initial body weight), C-reactive protein (CRP in mg/l), and hemoglobin (Hb, g/100 ml) were retrieved from charts. For analysis, we classified weight loss into 3 categories (< 5%, 5-9.9%, and ≥ 10% of usual body weight). Of full MNA items, we have considered the question A (AMNA score) recording the food intake in three categories, the question K (KMNA) recording high-protein containing food intake in three catego- ries, and the question R (CC) recording the calf circumference in 2 categories (Fig.1). We considered that KMNA records specifically appetite for protein. These three MNA questions have been shown to be independent predictors for 1-year mortality [6]. Actual protein intake was assessed by a 1-day diet recall for the day before each chemotherapy session. Energy intake at baseline was categorized into three classes: low: < 20 kcal kg^{-1} day^{-1}, fair: 20–30 kcal kg^{-1} day^{-1}, and normal: > 30 kcal kg^{-1} day^{-1}. Protein intake was categorized into three classes: very low: < 0.8 g kg^{-1} day^{-1}; low-medium: 0.8 to 1.0 g kg^{-1} day^{-1}; and good-high: > 1.0 g kg^{-1} day^{-1}.

The assessment of HRQoL and CGA was optional in this trial, depending on the availability of geriatric team in the clinical setting. Physical functioning and fatigue symptoms were evaluated from the corresponding scales of the European Organisation for Research and Treatment of Cancer (EORTC) Cancer Quality of Life Questionnaire-C30 (QLQC30) [12]. The scores (/100) were calculated using the formulas set by the EORTC. A score of 100 in the QLQC30 physical functioning indicates excellent physical condition, and a score of 100 in the QLQC30 fatigue indicates extreme fatigue. We focused on these QLQC30 domains because physical functioning and fatigue may be impaired with de- creased appetite in patients with cancer [10].

The CGA included the following items. Physical per- formance was assessed with the Timed Up and Go test (TUG), and the one-leg stance test (OLS). The TUG is the time in seconds taken to rise from an armchair, walk 3 m and back, and sit again. We also recorded the maximum duration of a OLS in seconds. Functional dependence was evaluated using the activities of daily living (ADL), [13] and the instrumental activities of daily living (IADL [14]). Scores of 0 and 8 on the ADL and IADL respectively indicate full independence. Depressive symptoms were assessed using the Geriatric Depression Scale 15 items (GDS-15

[15]) with scores higher than 5 indicating a high probability of depression and score higher than 10 almost always indicating a depression.

Fig. 1 Questions extracted from the full MNA©

AMNA: Has food intake declined over the 3 months due to loss of appetite, digestive problems, chewing or swallowing difficulties?
0 = severe decrease in food intake
1 = moderate decrease in food intake
2 = no decrease of food intake

KMNA: Selected consumption markers for protein intake
At least on serving of dairy products (milk, cheese, yoghurt) per day
yes/no
Two or more servings of legume or eggs per week
yes/no
Meat fish or poultry every day
yes/no
0.0 if 0 or 1 yes
0.5 if 2 yes
1.0 if 3 yes

Calf circumference (CC) in cm
0 = CC less than 31
1 = CC 31 or greater

Outcomes

The worsening of HRQol (fatigue and physical functioning) was the study main outcomes. We arbitrarily defined a de- crease of 20/100 in physical functioning and increase in 30/ 100 of fatigue scores during the chemotherapy treatment pe- riod as clinically pertinent [16]. CGA worsening was a sec- ondary outcome. A 10% increase in the TUG and a 10% decrease in the OLS times (left or right) or inability to perform the tests were considered to indicate worsening of measured physical performance. An increase of 1 point or more in the ADL or the decrease of one point or more in the IADL was considered to indicate worsening of functional dependence. Finally, an increase of one point or more in the GDS-15 was considered to indicate worsening of depressive symptoms.

Statistical analysis

The non-adjusted comparisons for changes in body weight, HRQoL, GDS, ADL, and IADL between UC and UCNI groups during RCT dietary intervention (and chemotherapy treatment) were performed with student t test.

We performed a cross-sectional analysis of the relation- ships of nutritional variables with HRQoL and CGA recorded at the end of the chemotherapy period. Distributions of QLQC30 physical functioning and fatigue, TUG, OLS, ADL, and IADL according to group allocation, end of che- motherapy questions AMNA, KMNA, CC, weight loss during chemotherapy in categories (none or weight gain, 0.1–5% and > 5% of body weight), and categories of final

total or protein intake were examined by ANOVA. Correlations be- tween outcomes and end of chemotherapy Hb were also re- ported. Data on patient's end of chemotherapy CRP were not available.

We then applied step-by-step backward logistic multino- mial regression models to assess the effects of dietary inter- vention and nutritional baseline assessment items (AMNA, KMNA, total and protein intake categories, weight loss cate- gories, and CC) on each outcome with adjustment on age and gender. Variables were inserted into the model when univar- iate p values were < 0.225. Odd ratios (OR) and 95% confi- dence intervals (95% CI) are reported. In all analyses, $p < 0.05$ was considered statistically significant. All analyses were per- formed using SPPS ©Statistics.

Results

The RCT included 341 subjects who were randomized into the two study groups (Fig.2). Patients with missing data at baseline regarding nutrition and quality of life were excluded and 57 deaths occurred during the chemotherapy period (max- imum 6 months). Finally, 155 subjects (77 women, mean age 77.3 years, SD 4.8 years) had two quality of life assessments and were analyzed. The subjects lost for follow-up were not different from the included subjects for baseline-studied vari- ables. Subjects who died before the end of chemotherapy had lower baseline dietary intake according to AMNA than did subjects who were included in the present study (chi 2 test, $p = 0.042$). The distribution of cancer types according to inter- vention group is shown in Supplemental Table 1. Colon can- cer and lymphoma were the most frequent cancers. Table 1 shows the baseline HRQoL and CGA items according to nu- tritional variables. Although MNA indicated that all patients were at risk of malnutrition and not undernourished 23 (15%) had severe decreases in global intake (AMNA), 38 (31%) patients had protein intake < 0.8 g kg^{-1} day^{-1}, 78 (66%) patients had > 5% of body weight loss prior to treatment, and 18 (12%) patients had CC < 31 cm.

End-of-chemotherapy cross-sectional analysis

At the end of the treatment period, the dietary intervention showed no effect on any of the variables examined.

Severe reported decrease in dietary intake (AMNA) was associated with greater ADL dependence ($p = 0.026$). However, total energy intake was not related to any of the variables examined. Weight loss during chemotherapy was related to lower QLQC30 physical functioning ($p = 0.001$), decreased OLS time ($p < 0.0001$), greater ADL dependence ($p = 0.001$), and IADL dependence ($p = 0.011$). Low CC was associated with lower QLQC30 physical functioning ($p = 0.001$), higher levels of fatigue ($p = 0.018$), and greater depen-

dence for ADL (p = 0.004) and IADL (p = 0.002) (Table 2). Higher Hb levels at the end of chemotherapy were correlated with better QLQC30 physical functioning (r = 0.291, p = 0.004), less fatigue (r = − 0.227, p = 0.032), lower GDS scores (r = − 0.264, p = 0.006), and lesser ADL dependence (r = − 0.208, p = 0.042).

Worsening of the HrQoL

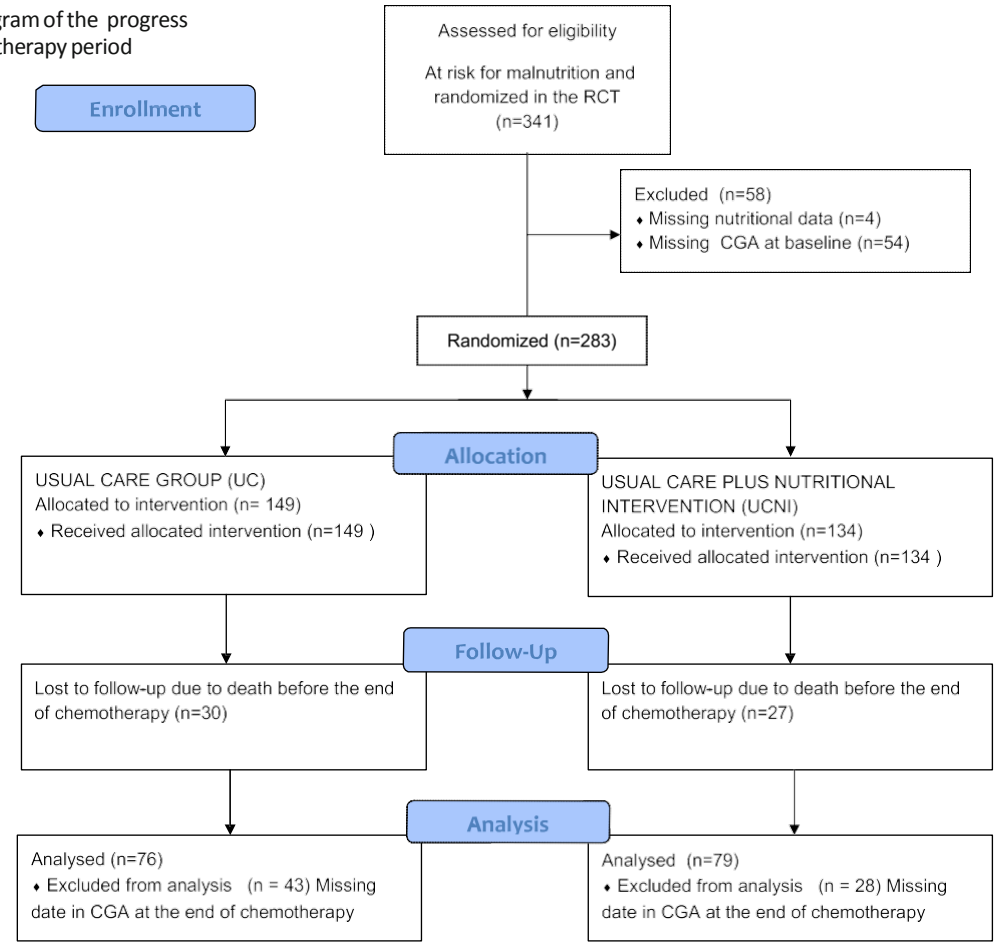
During the chemotherapy period, we observed a worsening of QLQC30 physical functioning in 37 (23.9%) patients and fa- tigue in 55 (36.9%) patients. The dietary intervention in comparison with routine care did not modify the HrQoL changes.

Worsening of QLQC30 fatigue was predicted by baseline low protein intake (OR 3.02, 95% CI 1.22–7.46, p = 0.018). None of the explored baseline variables was significantly associated with a worsening in QLQC30 physical functioning.

Worsening of the CGA

Worsening of CGA items was observed for GDS in 78 (51.6%) patients, TUG in 72 (50.0%) patients, OLS in 114 (76.5%) patients, ADL in 23 (14.9%) patients, and of IADL in 54 (34.8%)

Fig. 2 CONSORT diagram of the progress through the chemotherapy period



patients. Overall, 150 (96.8%) subjects worsened any of parameters.

There was no difference between groups of dietary inter- vention for any outcomes. Baseline ADL data were not nor- mally distributed, and ADL difference between groups was compared with a Mann-Whitney test and there were no differ- ence according groups.

Worsening of ADL was predicted by baseline low protein intake (OR 5.21, 95%CI 1.18–22.73, p = 0.029 respectively). An increase in depressive symptoms was predicted by 5–9.9% weight loss prior to chemotherapy (OR 2.66, 95% CI 1.10– 6.79, p = 0.038). Men were at increased risk to worsen their ADL dependence and women to increase their depressive symptoms (Table 3). None of the explored baseline variables was significantly associated with a worsening in TUG, OLS, or IADL.

Discussion

This study demonstrated association of weight loss and poor protein intake with worsening of fatigue, increased depressive symptoms, and loss of functional independence in older people at risk of malnutrition during chemotherapy for cancer. However, no effect of the dietary intervention on HRQoL or CGA was observed.

Previous studies have shown an association of malnutrition and malnutrition risk assessed by patient-generated subjective global assessment (PG-SGA) or by MNA with impairment of HRQoL [17, 18]. Here, we selected subjects at risk of malnu- trition, and consequently, undernourished or normally nourished patients were not represented. Therefore, we fo- cused mainly on longitudinal worsening of HRQol and end of chemotherapy HRQoL in survivors.

The choice of clinically relevant thresholds to define wors- ening was mainly empirical. In a recent study, the minimal clinically significant difference in general health status was estimated to be 5/100 for older patients receiving chemother- apy [19]. In our study, the standard deviations of changes in QLQC30 fatigue and physical functioning were much greater than 5, probably because the study population consisted of subjects with poor quality of life. Using our definitions from one-third to one-half of the patients worsened the examined domains of HRQoL and CGA. Furthermore, almost all expe- rienced worsening of at least one HRQoL or CGA studied item. We have evidenced the important role of low protein intake in quality of life worsening. Surprisingly, measured total intake from dietary recall was unrelated to quality of life evolution. Notably, the negative effect was limited to the very low protein intake category and not to the intermediate intake category. Several lines of evidence indicate that muscle anab-lism in older patients (without cancer) can be increased with protein intake higher than 1.2 $g \cdot kg^{-1}$ day^{-1} [20]

Table 1 Baseline characteristics for health-related quality of life of included subjects according to nutritional parameters

	Intervention group		AMNA decreased food intake			KMNA decreased protein-rich food intake			Protein intake categories $g.kg^{-1}$ day^{-1}			Weight loss prior treatment % body weight			CC calf circumference	
Mean (SD)	UC $n=76$	UC NI $n=79$	Severe $n=23$	Moderate $n=84$	No $n=43$	Severe $n=6$	Moderate $n=36$	No $n=108$	<0.8 $n=38$	0.8–1 $n=33$	>1 $n=52$	<5 $n=40$	5–9.9 $n=36$	≥ 10 $n=42$	<31 cm $n=18$	≥ 31 cm $n=132$
Age	77.8 (4.8)	76.9 (4.7)	76.3 (4.8)	77.5 (4.7)	77.3 (4.8)	78.5 (5.0)	77.2 (4.9)	77.3 (4.7)	78.2 (5.3)	77.7 (4.7)	76.5 (4.3)	77.5 (4.6)	77.0 (4.4)	77.2 (5.3)	76.6 (4.7)	77.4 (4.8)
Gender (M/F)	45/31	33/46	11/12	43/22	23/20	5/1	19/17	54/58	19/20	18/15	28/25	18/22	20/16	23/19	10/8	68/67
Physical functioning (0–100), 100 the best function	74.6 (20.2)	71.6 (22.3)	70.3 (18.4)	72.7 (21.5)	71.5 (22.7)	70.0 (21.4)	72.6 (17.8)	72.5 (22..6)	70.5 (22.3)	75.4 (20.7)	77.3 (16.7)	75.8 (21.1)	71.1 (20.0)	71.6 (20.1)	65.5 (22.0)	74.2 (21.2)
Timed Up and Go test, s	15.7 (9.2)	15.9 (7.2)	19.1 (7.3)	14.1 (5.9)	17.5 (11.8)	14.4 (2.6)	15.7 (5.9)	16.0 (9.4)	14.7 (7.3)	15.4 (5.3)	17.1 (6.6)	14.7 (5.0)	16.2 (5.9)	13.8 (7.0)	18.7 (16.4)	15.4 (6.5)
One-leg stance test, s	7.4 (7.6)	6.0 (7.2)	3.1 (2.7)	7.2 (8.4)	7.4 (6.4)	6.0 (4.1)	7.3 (8.5)	6.4 (7.4)	5.6 (6.1)	6.0 (5.1)	6.3 (5.8)	6.9 (8.3)	6.5 (5.3)	7.6 (8.4)	8.8 (9.7)	6.3 (7.0)
Fatigue (0–100), 100 the highest level of fatigue	42.2 (28.3)	39.6 (24.6)	41.4 (29.3)	39.6 (26.1)	43.3 (26.1)	40.7 (30.4)	42.8 (28.4)	40.9 (26.5)	45.6 (26.7)	45.9 (27.8)	35.9 (24.3)	38.5 (26.1)	42.2 (25.7)	39.3 (26.1)	51.6 (33.6)	39.5 (25.2)
GDS-15 (0–15, 0: no symptoms)	4.6 (2.7)	5.5 (3.0)	5.6 (3.3)	4.9 (3.0)	5.0 (2.4)	4.3 (3.8)	5.8 (3.4)	4.8 (2.6)	4.6 (3.0)	4.8 (20.3)	5.6 (2.9)	4.5 (2.3)	5.2 (2.8)	4.8 (3.0)	5.4 (2.4)	5.0 (3.0)
ADL (0–6, 0: full independence)	0.55 (1.27)	0.59 (1.41)	0.78 (1.31)	0.46 (1.22)	0.67 (1.58)	0.50 (1.23)	0.44 (0.84)	0.62 (1.48)	0.50 (1.16)	0.39 (0.79)	0.37 (0.89)	0.40 (0.78)	0.44 (0.81)	0.36 (0.85)	0.89 (1.88)	0.53 (1.25)
IADL (0–8, 8: full independence)	6.52 (1.67)	6.50 (1.72)	6.14 (1.65)	6.69 (1.59)	6.31 (1.88)	6.33 (1.34)	6.53 (1.50)	6.50 (1.80)	6.26 (1.69)	6.82 (1.53)	6.76 (1.54)	6.90 (1.47)	6.46 (1.56)	6.32 (1.68)	6.00 (2.03)	6.57 (1.64)

UC usual care group, *UCNI* usual care + nutritional intervention group. Physical functioning and fatigue are issued from QLQC30 (EORTC quality of life questionnaire); *GDS* geriatric depression scale, *ADL* activities of daily living, *IADL* instrumental activities of daily living

Table 2 End of chemotherapy health-related quality of life of included subjects according to end of chemotherapy nutritional parameters

	AMNA decreased food intake			KMNA decreased protein-rich food intake			Protein intake categories $g.kg^{-1}$ day^{-1}			Weight loss during treatment % body weight			CC calf circumference	
Mean (SD)	Severe n = 22	Moderate *n* = 57	No *n* = 73	Severe n = 5	Moderate *n* = 26	No *n* = 121	< 0.8 *n* = 13	0.8–1 *n* = 11	> 1 *n* = 22	< 5 *n* = 61	5–9.9 n = 38	≥ 10 = 46	< 31 cm *n* = 22	≥ 31 cm *n* = 132
Physical functioning (0–100), 100 the best function	64.8 (24.7)	66.7 (24.0)	73.9 (21.7)	64.0 (20.3)	63.1 (21.7)	71.6 (23.5)	68.2 (15.4)	75.8 (16.4)	67.9 (25.6)	77.1 (18.-1)*	68.8 (21.0)	60.1 (22.9)	54.6 (27.4-)*	72.1 (21.5)
Timed Up and Go test, s	18.0 (14.0)	15.8 (6.2)	15.6 (6.4)	15.5 (11.4)	14.5 (5.5)	16.3 (7.9)	17.8 (15.1)	15.1 (6.9)	17.8 (6.3)	14.7 (5.9)	16.8 (10.1)	18.3 (6.7)	19.4 (8.5)	15.5 (7.2)
One-leg stance test, s	6.2 (4.2)	4.6 (5.2)	4.7 (5.9)	12.2 (15.6) +	3.3 (3.4)	4.6 (5.4)	2.2 (2.7)	3.6 (3.1)	4.7 (4.4)	6.5 (6.4) #	3.2 (3.8)	2.4 (2.5)	3.1 (3.2)	4.9 (6.1)
Fatigue (0–100), 100 the highest level of fatigue	49.2 (27.3)	41.1 (28.2)	37.9 (24.6)	42.2 (25.3)	43.6 (23.1)	40.2 (27.6)	42.7 (30.0)	23.3 (12.2)	41.3 (26.1)	33.7 (20.-8) +	44.7 (30.9)	49.6 (25.7)	53.4 (29.1-)°	38.8 (25.4)
GDS-15 (0–15, 0: no symptoms)	6.3 (3.4)	5.4 (3.2)	5.3 (2.9)	4.0 (2.1)	6.7 (2.7)	5.3 (3.1)	6.5 (2.7)	4.7 (2.5)	6.2 (2.4)	5.2 (3.1)	5.3 (3.1)	6.0 (2.8)	6.7 (3.2)	5.3 (6.1)
ADL (0–6, 0: full independence)	1.73 (2.69)**	0.93 (2.4)	0.44 (1.21)	1.80 (3.49)	0.73 (1.85)	0.79 (1.98)	0.92 (2.0)	0.00 (0.00)	0.73 (1.58)	0.15 (0.5-1)*	0.92 (1.9)	1.49 (2.7)	1.95 (3.11-)°°	0.61 (1.70)
IADL (0–8, 8: full independence)	5.32 (2.60)	5.91 (2.19)	6.23 (2.22)	4.40 (3.21)	6.31 (2.07)	5.98 (2.27)	6.08 (1.61)	7.45 (1.04)	6.18 (2.13)	6.62 (1.7-1)Ŧ	5.87 (2.13)	5.35 (2.67)	4.73 (2.93-)##	6.27 (2.01)

Physical functioning and fatigue are issued from QLQC30 (EORTC quality of life questionnaire). *GDS* geriatric depression scale, *ADL* activities of daily living, *IADL* instrumental activities of daily living

*#+ Ŧ**°°°##ANOVA: $p = 0.001$; $p < 0.0001$, $p = 0.007$, $p = 0.011$, $p = 0.026$, $p = 0.018$, $p = 0.004$, $p = 0.002$

Table 3 Multivariate models assessing the predictive value of baseline nutritional assessment in the worsening of physical functioning or fatigue according to EORTC QLQC30, quality of life questionnaire, depressive symptoms according to the GDS-15 scale, and activities of daily living (ADL) during the chemotherapy period

	QLQC30 physical functioning worsening			QLQC30 fatigue worsening			GDS (depressive symptoms) worsening			ADL worsening		
	OR	95% CI	*p*	OR	95% CI	*p*	OR	95% CI	*p*			
Age (for one year more)	1.05	0.96–1.15	0.293	1.00	0.90–1.10	0.651	1.00	0.91–1.07	0.987	0.96	0.86–1.08	0.502
Gender male versus female	0.69	0.29–1.61	0.390	1.00	0.50–2.20	0.964	0.62	0.29–1.35	0.025	4.14	1.20–14.30	0.025
Protein intake categories												
<0.8 g.kg^{-1} day^{-1}	2.64	0.97–5.28	0.057	3.02	1.22–7.46	0.018	-			5.21	1.18–22.73	0.029
0.8.1 g.kg^{-1} day^{-1}	1.68	0.56–4.93	0.356	1.36	0.52–3.56	0.575				2.13	0.43–10.64	0.354
>1 g.kg^{-1} day^{-1}	1			1						1		
Weight loss prior chemotherapy												
<5% $n = 40$							1			1		
5–9.9% $n = 33$							2.66	1.04–6.78	0.040	8.55	1.43–52.63	0.019
≥10% $n = 42$							1.35	0.55–3.29	0.511	4.61	0.81–26.32	0.085

Factors studied in the models were age and gender, baseline A-MNA, K-MNA, CC, protein intake in categories, and weight loss before chemotherapy

However, increased anabolism may not be sufficient to improve muscle performance. In a group of community-living older subjects (without cancer), protein intake higher than 1 g·kg^{-1} day^{-1} was not related to better physical performance, but the inter- action between higher intake and physical activity was asso- ciated with better quality of life [21].

In another study of older subjects with solid tumors, normal nutritional status according to the MNA was associated with a lesser HRQoL decline [17]. Conversely, weight loss after gas- tric cancer surgery was shown to be associated with long-term functional loss [22]. However, we found no difference in any outcome including HRQoL according to dietary intervention despite an observed increase in dietary intake. Similar results have been reported in younger patients [23–25]. We have previously interpreted the lack of effect of dietary intervention on mortality and body weight, considering the anti-anabolic state of cachectic subjects. Intervention focusing on anti- cachectic treatment may prevent the worsening of HRQoL in older people during chemotherapy. A meta-analysis evi- denced benefits of high protein and omega-3 enriched diet on body weight and on physical functioning [26]. The addi- tion of physical activity may further enhance anabolism and improve performance in older patients with cancer.

Our study has several limitations. The group was heteroge- neous in term of tumor locations. Due to the design of the main study, the population included only “at risk for malnu- trition” patients according to the MNA and no malnourished or normally nourished subjects. Several subjects (42 here) had loss more than 10% of their body weight and were not con- sidered malnourished. This suggests that other items of the MNA were optimal and thus that they had good prognosis factors besides this important weight loss. The population sample size was not calculated to address the objectives of the present post hoc

analysis but to appreciate an effect on mortality. Due to missing HRQoL assessments, the number of subjects consisted in half of the initial population which limited the statistical power of analysis. Furthermore, missing data for dietary recall at the end of chemotherapy period re- duced the statistical power of cross-sectional analysis. This lack of power could explain we found no cross-sectional rela- tionship of QLQC30 physical functioning and physical per- formance scores with nutritional parameters at the end of the chemotherapy period. The dietary record consisted of one-day recall, which may be insufficient to provide an accurate esti- mation of intake. The dietary intervention may have been insufficient to significantly increase protein intake. However, we reported previously that the proportion of subjects reaching the targeted protein intake (1.2 $g \cdot kg^{-1}$ day^{-1} - body weight) was 46.8% in the UCNI group compared with 20.8% in the UC. Here, the "at risk group" had very low protein intake (< 0.8 $g \cdot kg^{-1}$ day^{-1}) and may be those who did not reached the target for protein intake.

However, the findings of this study emphasize the importance of screening for very low protein intake to identify patients at high risk of quality of life decline including functional decline. The results support a rationale for focused dietary intervention using anti-cachectic strategies in this group of patients.

References

1. Glaus A (1998) Fatigue and cachexia in cancer patients. Support Care Cancer 6:77–78. https://doi.org/10.1007/s005200050137
2. Hofer F, Koinig KA, Nagl L, Borjan B, Stauder R (2018) Fatigue at baseline is associated with geriatric impairments and represents an adverse prognostic factor in older patients with a hematological malignancy. Ann Hematol 97:2235–2243. https://doi.org/10.1007/ s00277-018-3420-8
3. Soubeyran P, Bellera C, Goyard J, Heitz D, Cure H, Rousselot H, Albrand G, Servent V, Jean OS, van Praagh I, Kurtz JE, Perin S, Verhaeghe JL, Terret C, Desauw C, Girre V, Mertens C, Mathoulin-Pelissier S, Rainfray M (2014) Screening for vulnerabil- ity in older cancer patients: the ONCODAGE prospective multicen- ter cohort study. PLoS One 9:e115060. https://doi.org/10.1371/ journal.pone.0115060
4. Guigoz Y, Lauque S, Vellas BJ (2002) Identifying the elderly at risk for malnutrition. The Mini Nutritional Assessment. Clin Geriatr Med 18:737–757
5. Bourdel-Marchasson I, Blanc-Bisson C, Doussau A, Germain C, Blanc JF, Dauba J, Lahmar C, Terrebonne E, Lecaille C, Ceccaldi J, Cany L, Lavau-Denes S, Houede N, Chomy F, Durrieu J, Soubeyran P, Senesse P, Chene G, Fonck M (2014) Nutritional advice in older patients at risk of malnutrition during treatment for chemotherapy: a two-year randomized controlled trial. PLoS One 9: e108687
6. Bourdel-Marchasson I, Diallo A, Bellera C, Blanc-Bisson C, Durrieu J, Germain C, Mathoulin-Pelissier S, Soubeyran P, Rainfray M, Fonck M, Doussau A (2016) One-year mortality in older patients with cancer: development and external validation of an MNA-based prognostic score. PLoS One 11:e0148523. https:// doi.org/10.1371/journal.pone.0148523
7. Senesse P, Bachmann P, Bensadoun RJ, Besnard I, Bourdel- Marchasson I, Bouteloup C, Crenn P, Goldwasser F, Guerin O, Latino-Martel P, Meuric J, May-Levin F, Michallet M, Vasson MP, Hebuterne X (2014) Clinical nutrition guidelines of the French Speaking Society of Clinical Nutrition and Metabolism (SFNEP): summary of recommendations for adults undergoing non-surgical anticancer treatment. Dig Liver Dis 46:867–874
8. Fearon KC, Voss AC, Hustead DS (2006) Definition of cancer cachexia: effect of weight loss, reduced food intake, and systemic inflammation on functional status and prognosis. Am J Clin Nutr 83:1345–1350
9. Raijmakers NJH, Zijlstra M, van Roij J, Husson O, Oerlemans S, van de Poll-Franse LV (2018) Health-related quality of life among cancer patients in their last year of life: results from the PROFILES registry. Support Care Cancer 26:3397–3404. https://doi.org/10. 1007/s00520-018-4181-6

10. Barajas Galindo DE, Vidal-Casariego A, Calleja-Fernandez A, Hernandez-Moreno A, Pintor de la Maza B, Pedraza-Lorenzo M, Rodriguez-Garcia MA, Avila-Turcios DM, Alejo-Ramos M, Villar-Taibo R, Urioste-Fondo A, Cano-Rodriguez I, Ballesteros- Pomar MD (2017) Appetite disorders in cancer patients: impact on nutritional status and quality of life. Appetite 114:23–27. https:// doi.org/10.1016/j.appet.2017.03.020
11. Wei J, Li S (2018) The relationship between nutritional risks and cancer-related fatigue in patients with colorectal cancer fast-track surgery. Cancer Nurs 41:E41–E47
12. Aaronson NK, Ahmedzai S, Bergman B, Bullinger M, Cull A, Duez NJ, Filiberti A, Flechtner H, Fleishman SB, de Haes JC et al (1993) The European Organization for Research and Treatment of Cancer QLQ-C30: a quality-of-life instrument for use in international clinical trials in oncology. J Natl Cancer Inst 85:365–376. https://doi.org/10.1093/jnci/85.5.365
13. Katz S, Downs TD, Cash HR, Grotz RC (1970) Progress in devel- opment of the index of ADL. Gerontologist 10:20–30
14. Lawton MP, Brody EM (1969) Assessment of older people: self- maintaining and instrumental activities of daily living. Gerontologist 9:179–186
15. Sheikh J, Yesavage J (1986) Geriatric depression scale (GDS): recent evidence and development of a shorter version clinical ger- ontology : a guide to assessment and intervention. The Haworth Press, New York, pp 165–173
16. Sultan A, Choudhary V, Parganiha A (2017) Worsening of rest- activity circadian rhythm and quality of life in female breast cancer patients along progression of chemotherapy cycles. Chronobiol Int 34:609–623. https://doi.org/10.1080/07420528.2017.1286501
17. Decoster L, Quinten C, Kenis C, Flamaing J, Debruyne PR, De Groof I, Focan C, Cornelis F, Verschaeve V, Bachmann C, Bron D, Luce S, Debugne G, den Bulck, Goeminne JC, Baitar A, Geboers K, Petit B, Langenaeken C, Van Rijswijk R, Specenier P, Jerusalem G, Praet JP, Vandenborre K, Lobelle JP, Lycke M, Milisen K, Wildiers H (2019) Health related quality of life in older patients with solid tumors and prognostic factors for decline. J Geriatr Oncol 10:895–903. https://doi.org/10.1016/j.jgo.2019.03. 018
18. Guo ZQ, Yu JM, Li W, Fu ZM, Lin Y, Shi YY, Hu W, Ba Y, Li SY, Li ZN, Wang KH, Wu J, He Y, Yang JJ, Xie CH, Song XX, Chen GY, Ma WJ, Luo SX, Chen ZH, Cong MH, Ma H, Zhou CL, Wang W, Luo Q, Shi YM, Qi YM, Jiang HP, Guan WX, Chen JQ, Chen JX, Fang Y, Zhou L, Feng YD, Tan RS, Li T, Ou JW, Zhao QC, Wu JX, Deng L, Lin X, Yang LQ, Yang M, Wang C, Song CH, Xu HX, Shi HP, Investigation on the Nutrition S and Clinical Outcome of Common Cancers G (2019) Survey and analysis of the nutrition- al status in hospitalized patients with malignant gastric tumors and its influence on the quality of life. Support Care Cancer 28:373– 380. https://doi.org/10.1007/s00520-019-04803-3
19. Quinten C, Kenis C, Decoster L, Debruyne PR, De Groof I, Focan C, Cornelis F, Verschaeve V, Bachmann C, Bron D, Luce S, Debugne G, Van den Bulck H, Goeminne JC, Baitar A, Geboers K, Petit B, Langenaeken C, Van Rijswijk R, Specenier P, Jerusalem G, Praet JP, Vandenborre K, Lycke M, Flamaing J, Milisen K, Lobelle JP, Wildiers H (2019) Determining clinically important differences in health-related quality of life in older patients with cancer undergoing chemotherapy or surgery. Qual Life Res 28: 663–676.https://doi.org/10.1007/s11136-018-2062-6
20. Baum JI, Kim IY, Wolfe RR (2016) Protein consumption and the elderly: what is the optimal level of intake? Nutrients 8. https://doi. org/10.3390/nu8060359
21. Ten Haaf DSM, van Dongen EJI, Nuijten MAH, Eijsvogels TMH, de Groot L, Hopman MTE (2018) Protein intake and distribution in relation to physical functioning and quality of life in community- dwelling elderly people: acknowledging the role of physical activ- ity. Nutrients 10. https://doi.org/10.3390/nu10040506
22. Climent M, Munarriz M, Blazeby JM, Dorcaratto D, Ramon JM, Carrera MJ, Fontane L, Grande L, Pera M (2017) Weight loss and quality of life in patients surviving 2 years after gastric cancer re- section. Eur J Surg Oncol 43:1337–1343. https://doi.org/10.1016/j. ejso.2017.01.239
23. Lee JLC, Leong LP, Lim SL (2016) Nutrition intervention ap- proaches to reduce malnutrition in oncology patients: a systematic review. Support Care Cancer 24:469–480. https://doi.org/10.1007/ s00520-015-2958-4
24. Poulsen GM, Pedersen LL, Osterlind K, Baeksgaard L, Andersen JR (2014) Randomized trial of the effects of individual nutritional counseling in cancer patients. Clin Nutr 33:749–753. https://doi. org/10.1016/j.clnu.2013.10.019
25. Uster A, Ruefenacht U, Ruehlin M, Pless M, Siano M, Haefner M, Imoberdorf R, Ballmer PE (2013) Influence of a nutritional inter- vention on dietary intake and quality of life in cancer patients: a randomized controlled trial. Nutrition 29:1342–1349. https://doi. org/10.1016/j.nut.2013.05.004
26. de van der Schueren MAE, Laviano A, Blanchard H, Jourdan M, Arends J, Baracos VE (2018) Systematic review and meta-analysis of the evidence for oral nutritional intervention on nutritional and clinical outcomes during chemo (radio)therapy: current evidence and guidance for design of future trials. Ann Oncol 29:1141– 1153. https://doi.org/10.1093/annonc/mdy114