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Institutionelle Grenzen erweitern - der ‚Life-Space' von Bewohnern in der stationären Altenpflege und dessen Modifikation mittels eines Trainingsprogramms zur Steigerung der körperlichen Aktivität

vorgelegt von
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Hinweis für die Leserin/den Leser:

Zu Gunsten eines besseren Leseflusses werden in der vorliegenden Arbeit im Regelfall Ausdrucksformen männlichen Geschlechts, wie Studienteilnehmer oder (Pflegeheim-) Bewohner, verwendet. Dennoch sei explizit darauf hingewiesen, dass dabei immer auch Studienteilnehmerinnen und Pflegeheimbewohnerinnen gemeint sind.

Danksagung

Die vorliegenden, gedruckten Seiten Papier sind letztendlich nichts als der Kulminationspunkt eines Prozesses, den ich in den vorangegangenen Jahren durchlaufen habe. An diesem Prozess waren zahlreiche Personen beteiligt, denen Dank gebührt und ohne die eine Vollendung dieser Dissertation nicht möglich gewesen wäre.

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Inhaltsverzeichnis

Liste der Veröffentlichungen zur publikationsbasierten Dissertation[1]

Manuskript I
Jansen, C.-P., Claßen, K., Wahl, H.-W., & Hauer, K. (2015). Effects of interventions on physical activity in nursing home residents. *European Journal of Ageing*, *12* (3), 261-271. doi: 10.1007/s10433-015-0344-1

Manuskript II
Jansen, C.-P., Claßen, K., Hauer, K., Diegelmann, M., & Wahl, H.-W. (2014). Assessing the effect of a physical activity intervention in a nursing home ecology: a natural lab approach. *BMC Geriatrics,* 14: 117. doi: 10.1186/1471-2318-14-117

Manuskript III
Jansen, C.-P., Diegelmann, M., Schnabel, E.-L., Wahl, H.-W., & Hauer, K. (2017). Life-Space and movement behavior in nursing home residents: results of a new sensor-based assessment and associated factors. *BMC Geriatrics*, 17: 36. doi: 10.1186/s12877-017-0430-7

Manuskript IV
Jansen, C.-P., Diegelmann, M., Schilling, O. K., Werner, C., Schnabel, E.-L., Wahl, H.-W., & Hauer, K. (submitted). Pushing the boundaries: A physical activity intervention extends sensor-assessed life-space in nursing home residents. *The Gerontologist*.

Manuskript V
Jansen, C.-P., Claßen, K., Schnabel, E.-L., Diegelmann, M., Hauer, K., & Wahl, H.-W. (2015). Long-Term-Care in Motion (LTCMo) – A Guidebook. Download unter http://www.innovage.group.shef.ac.uk/assets/images/D5.1%20Guidebook_Final%20Version%202.0.pdf

[1] Manuskript I wurde als erste Arbeit eingereicht, ist aufgrund der unterschiedlichen Dauer der Reviewprozesse jedoch zeitlich erst nach Manuskript II veröffentlicht worden.
Weitere Publikationen und Kongressbeiträge in Erst- oder Co-Autorenschaft des Autors, welche verbunden mit LTCMo entstanden sind, jedoch nicht in die Dissertation mit aufgenommen wurden, sind am Ende der Arbeit aufgelistet.

Abstract (Deutsch)

Diese publikationsbasierte Dissertation widmet sich der Beschreibung des Life-Space von Bewohnern der stationären Altenpflege sowie der Entwicklung und Evaluation eines individualisierten, mehrdimensionalen Interventionsansatzes zur Life-Space Modifikation mit Schwerpunkt auf körperlichem Training.

Manuskript I ist eine systematische Übersichtsarbeit (systematisches Review) zu randomisierten, kontrollierten Interventionsstudien (RCTs) im Pflegeheim und deren Effekte auf körperliche Aktivität von Pflegeheimbewohnern. Lediglich in acht RCTs wurde körperliche Aktivität erfasst, nur eine Studie betrachtete diese als primären Endpunkt. Interventionen, welche zusätzlich zu körperlichem Training auch psychosoziale und Verhaltensaspekte berücksichtigten und Pflegeheimpersonal miteinbezogen, zeigten die vielversprechendsten Effekte. Die starke Heterogenität der Interventionsprogramme und meist unzureichende psychometrische Qualität der Erhebungsmethoden schränkte die Interpretierbarkeit der Ergebnisse jedoch ein.

Basierend auf den Erkenntnissen aus dem systematischen Review wurden die Interventionsbausteine und Erhebungsmethoden zur Erfassung des Bewegungsverhaltens in Form von Life-Space Nutzung und körperlicher Aktivität konzipiert. Das entsprechende Studienprotokoll stellt Manuskript II dar.

In Manuskript III wird der Life-Space von Pflegeheimbewohnern erstmals unter Einsatz eines kabellosen Sensornetzwerks technisch sowie räumlich und zeitlich aufgelöst beschrieben. Der Life-Space der Bewohner (n = 65) war nahezu gänzlich auf das eigene Zimmer (36,6% des Tages wurden dort verbracht) und den das Zimmer umgebenden Wohnbereich (53,8%) beschränkt. Mittels linearer Regression wurde gezeigt, dass sozidodemografische Faktoren, motorische Leistung, kognitiver Status und psychosoziale Faktoren signifikant mit Life-Space-Parametern assoziiert sind. Die Hauptdeterminante der Life-Space-Nutzung stellte allerdings die institutionelle Essensroutine dar, die sowohl den Aufenthalt im öffentlichen Speiseraum als auch die Raumwechselhäufigkeit der Bewohner weitestgehend bestimmte.

In Manuskript IV werden positive Effekte der Intervention auf erfasste Life-Space-Parameter mittels generalized linear mixed models (GLMMs) analysiert und belegt (n = 143). Diese Analysestrategie toleriert dem Studienkollektiv entsprechend erwartbaren Datenausfall und die Nicht-Normalverteilung der Ergebnisvariablen. Die Parameter waren ein im Rahmen der Arbeit entwickelter Life-Space Summenscore,

welcher die „durchschnittliche“ Zone (Zone 1 = Privatzimmer; Zone 2 = Wohnbereich; Zone 3 = außerhalb des Wohnbereichs; Zone 4 = außerhalb des Gebäudes) beschreibt, in welcher sich ein Bewohner über den Tag aufhält (LSSc); die am weitesten vom jeweiligen Privatzimmer entfernte, vom Bewohner aufgesuchte Zone (MaxZ) als Maß für die absolute Ausdehnung des individuellen Life-Space; die Zeit, die ein Bewohner außerhalb des eigenen Zimmers verbringt (TAFR) als Maß für das Potenzial, an sozialen Interaktionen teilzuhaben. Es zeigten sich signifikante Gruppenunterschiede in LSSc (β = .13, *p* = .003), TAFR (β = .28, *p* = .015) und MaxZ (β = .29, *p* = .003) zwischen Prä- und Posttest in der Interventionsgruppe (n = 78) verglichen mit der Kontrollgruppe (n = 65). Ein signifikanter Effekt blieb zum Follow-Up nach drei Monaten für den Parameter MaxZ bestehen (β = .39, *p* = .012).

Manuskript V ist ein praxisorientiertes Handbuch, dass der Forderung einer breiten Dissemination und freien Verfügbarkeit des Programms nachkommen sowie eine praktische Implementierung des Interventionsprogramms seitens interessierter Endnutzer ermöglichen soll. Es beinhaltet Leitlinien für die Durchführung wissenschaftlicher Studien im Pflegeheimsetting, theoretischen und methodisch-didaktischen Hintergrund zu den Interventionsinhalten aus LTCMo, ein Assessmenttool zur Zuweisung von Teilnehmern zu geeigneten Trainingskomponenten und bebilderte Beschreibungen zahlreicher im Projekt eingesetzter Übungen.

Insgesamt belegen die Studienergebnisse einen sehr eingeschränkten Life-Space von Pflegeheimbewohnern, der jedoch trotz des engen institutionellen Rahmens durch den mehrdimensionalen Interventionsansatz mit Schwerpunkt auf individualisiertem körperlichen Training positiv verändert werden konnte. Dies gilt nahezu für das ganze Bewohnerspektrum der untersuchten Pflegeheime, ungeachtet schwerer kognitiver und motorisch-funktioneller Einschränkungen. Der Nachweis des Potenzials des Programms für eine nachhaltige Implementierung in Institutionen wurde durch die Studienergebnisse sowie die Tatsache, dass das Programm in beiden Studienheimen unabhängig fortgeführt wurde, erbracht. Die bisherige, auf fragebogenbasierten Erhebungsmethoden aufbauende Evidenz auf diesem Gebiet wurde mit der vorliegenden Arbeit durch neuartige, sensor-basierte Daten ergänzt. Während der Zusammenhang von Life-Space mit soziodemografischen, motorisch-funktionellen, kognitiven und psychosozialen Faktoren nachgewiesen wurde, stellt der Zusammenhang mit weiteren bedeutsamen Faktoren wie sozialer Teilhabe und Lebensqualität eine hochrelevante Fragestellung für zukünftige Forschungsvorhaben dar.

Abstract (Englisch)

This dissertation is based on the EU-funded project „Long-Term Care in Motion“ (LTCMo). It aims to provide an objective description of the life-space of nursing home residents using an innovative, wireless, sensor-based assessment allowing spatio-temporal resolution of life-space utilization. Furthermore, it addresses the development of an individualized, multi-component, physical activity promoting intervention with emphasis on physical exercise training and evaluates its effect on life-space parameters.

Manuscript I presents a systematic review of RCTs conducted within the nursing home setting, focussing on effects of interventions on residents‘ physical activity. As few as eight studies matched the inclusion criteria; only one of these addressed physical activity as primary outcome. Physical exercise combined with behavioral interventions and including nursing staff showed the most beneficial effects on physical activity. Interpretability of results was hampered by heterogeneous intervention programs and a large proportion of inadequate assessment methods of diverging psychometric quality.

Based on the results and conclusions of the systematic review, the conception of LTCMo‘s study intervention and assessment methods of physical activity and life-space was finalized and described in detail in a study protocol (Manuscript II).

Manuscript III describes the life-space of nursing home residents for the first time using an innovative, objective, sensor-based assessment superior to previous questionnaire-based assessments. Residents‘ (n = 65) life-space was largely restricted to the private room where residents spent 36.6% of the daytime, and the surrounding living unit (53.8%). Linear regression analyses revealed socio-demographic, motor, cognitive, and psychosocial factors to being associated with life-space parameters. The most important determinant of residents‘ life-space, however, was the institutional meal-routine, forcing residents to performing multiple transits between areas and spending time in the public dining area during the day.

Manuscript IV (n = 143) revealed significant positive effects of the individualized, multi-component intervention on life-space parameters of intervention participants compared to controls. Three life-space parameters were derived from the data: an overall score to describe the zone in which each resident lingered on average throughout the day (LSSc); the maximal zone a resident reached as a measure of the

overall extent of an individual's life-space (MaxZ); the time a resident spent away from the private room (TAFR) as a measure of abode in areas with high potential for social interaction. Statistical analysis was performed using generalized linear mixed models (GLMM), which facilitates dealing with non-normality of the response variable and allows for state-of-the-art missing data treatment instead of using listwise deletion. Results showed that after the intervention phase, the intervention group (n = 78) had a significantly higher LSSc (β = .13, *p* =.003), spent more time away from their own room (TAFR; β = .28, *p* = .015), and had a more extensive life-space (MaxZ; β = .29, *p* = .003) as compared to controls (n = 65). Sustainability of intervention effects at follow-up was found for MaxZ only (β = .39, *p* = .012).

To make the replication of this program as easy as possible for relevant stake-holders, Manuscript V was drafted as a guidebook. It comprehensively outlines the main goals of the program, provides information on the intervention program compo-nents including an exercise catalogue and fundamental didactical principles, and describes the implementation procedure including useful principles that can be employed when planning and preparing a project in institutional long-term care settings. It also contains an assessment tool for allocating participants into the program's different exercise components.

Overall, this study showed that sensor-assessed life-space of nursing home residents is severely restricted and, besides sociodemografic, motor, cognitive, and psychosocial factors, is mainly determined by institutional routines. Despite that, the multi-component, individualized intervention program focused on physical exercise training succeeded in modifying and enhancing participants' life-space parameters, irrespective of their cognitive status. To enhance current evidence on life-space in nursing home residents, and to avoid methodological weaknesses of previous questionnaire-based assessments, for the first time an objective sensor-based LS assessment with high spatiotemporal resolution was applied as part of this study.The fact that both study nursing homes incorporated the program into their weekly schedule for an autonomous continuation after the end of the intervention phase shows the program's high potential for sustainable implementation. Further research is needed to examine whether an enhancement of residents life-space also impacts on social participation and quality of life.

Anmerkungen

Die vorliegende publikationsbasierte Dissertation geht hervor aus dem Projekt „Langzeitpflege in Bewegung“ („Long-Term Care in Motion“, kurz LTCMo), einem Kooperationsprojekt der Abteilung für Psychologische Alternsforschung der Universität Heidelberg, unter Leitung von Prof. Dr. Hans-Werner Wahl, und der Forschungsabteilung des AGAPLESION Bethanien Krankenhauses Heidelberg, unter Leitung von Prof. Dr. Klaus Hauer. Das multidisziplinäre Projekt agierte in der Schnittstelle von Sportwissenschaft, Geriatrie und Gerontologie, sowie (Alterns-)Psychologie.
LTCMo war ein Teilprojekt des von der Europäischen Kommission geförderten Projekts „innovAge – Social Innovations Promoting Active and Healthy Ageing“, welches von Dezember 2012 bis November 2015 als Kooperationsprojekt von Institutionen aus 14 europäischen Ländern durchgeführt wurde. In fünf Teilprojekten sollten Strategien zur Verlängerung der „Healthy Life Expectancy“ („gesunde Lebenserwartung“) katalogisiert, entwickelt und evaluiert werden. Das Teilprojekt LTCMo war darauf ausgerichtet, die körperliche Aktivität und den Life-Space von Bewohnern der stationären Altenpflege positiv zu beeinflussen. Dies sollte durch eine individualisierte, mehrdimensionale Intervention mit Fokus auf körperlichem Training der Bewohner und zusätzlicher Schulung von Pflegeheimmitarbeitern, zur Förderung körperlich aktiven Verhaltens der Bewohner, erreicht werden. Verbunden damit war die Erwartung, eine Steigerung von Lebensqualität, psychosozialem Wohlbefinden und motorisch-funktioneller Leistungsfähigkeit zu erzielen. Ein besonderes Merkmal des Projekts war dessen integrativer Charakter, der die Teilnahme einer möglichst großen Anzahl an Bewohnern ungeachtet schwerer kognitiver und motorischer Einschränkungen und unter Anwendung möglichst weniger Ausschlusskriterien vorsah. Dies läuft zwar aufgrund von Nicht-Randomisierung den Kriterien „sauberer“ wissenschaftlicher Studien teilweise zuwider, zeigt aber die dezidierte, bedeutsame Absicht, dem sozialen (Innovations-) Charakter des Projekts sowie der intensiven, positiven Beeinflussung des Settings „Pflegeheim“ mindestens ebenso große Bedeutung zukommen zu lassen wie wissenschaftlichen Kriterien und Methoden. Nichtsdestotrotz war und ist die Evaluation des Programms ein sehr bedeutsamer Baustein des LTCMo-Projekts, der zugleich Gegenstand der vorliegenden Dissertation ist.

Der Verfasser dieser Arbeit war im Rahmen des Projekts zuständig für die praktische Durchführung und Koordination der körperlichen Trainingsintervention und umfangreichen Datenerhebung zu allen sieben Messzeitpunkten, die Koordination der zahlreichen wissenschaftlichen Hilfskräfte, die Kommunikation und Abstimmung aller Maßnahmen mit den Pflegeheimen sowie die Datenauswertung.

Überblick

Das LTCMo-Projekt war auf eine umfangreiche Beschreibung des Aktivitätsverhaltens von Bewohnern der stationären Altenpflege ausgerichtet. Die im Rahmen des Projekts implementierte Intervention verfolgte das wesentliche Ziel, das körperliche Aktivitätsverhalten der Bewohner zu steigern. Daher folgte die Konzeption der Intervention maßgeblich dieser Zielvorgabe. Der zweite, für das Projekt ebenso wichtige Endpunkt, war der Life-Space der Bewohner. Basierend auf den im theoretischen Hintergrund dargestellten Theorien und Hypothesen wurde davon ausgegangen, dass sich die Intervention zur Steigerung körperlicher Aktivität positiv auf den Life-Space der Bewohner auswirken würde. Dies ist zugleich die zentrale Fragestellung der vorliegenden Dissertation. Die Arbeit ist wie folgt aufgebaut:

Kapitel 1 liefert den theoretischen und empirischen Hintergrund zu Setting und Zielgruppe sowie Erhebungsmethoden und Endpunkten der Studie. Zu Beginn wird die Bedeutung der vorliegenden Arbeit abgeleitet von der Relevanz des Forschungsfelds „stationäre Altenpflege“ (Kap. 1.1) sowie den Eigenschaften und Besonderheiten der Studienzielgruppe der Pflegeheimbewohner (Kap. 1.2). Dem folgt die Einführung in das Life-Space Konzept und die Darstellung des aktuellen Forschungsstandes zum Thema (Kap. 1.3). Aufgrund des primären Interventionsziels, körperlich aktives Verhalten zu steigern, in Verbindung mit einer Erweiterung des individuellen Life-Space, wird nachfolgend körperliche Aktivität im Kontext der stationären Altenpflege beschrieben und diesbezügliche Evidenz dargestellt (Kap. 1.4). Mit Blick auf die besondere Lebensumwelt Pflegeheim und unter Bezugnahme auf entsprechende, aus der Umweltpsychologie hervorgegangene Verhaltensmodelle, dient Kapitel 1.5 zur Klärung der Frage, weshalb eine auf körperliche Aktivität ausgerichtete Intervention mit einer Verbesserung der Life-Space Nutzung einhergehen sollte. Zum Abschluss des ersten Kapitels werden bisher existierende Life-Space Erhebungsmethoden beschrieben und deren Vor- und Nachteile mit besonderer Berücksichtigung der Unterschiede zwischen fragebogen- und technik- bzw. sensorbasierten Verfahren diskutiert (Kap. 1.6). In Kapitel 2 werden die Fragestellungen und Ziele der einzelnen, in die Dissertation einfließenden Publikationen aus dem vorangegangen Kapitel abgeleitet und deren Publikationsreihenfolge begründet. Kapitel 3 besteht aus Zusammenfassungen der einzelnen Publikationen (Manuskript I bis V). Eine Einbettung der Ergebnisse und Schlussfolgerungen aus

allen Manuskripten in den Forschungszusammenhang erfolgt in Kapitel 4. Kapitel 5 bietet das abschließende Fazit aus der gesamten Arbeit und einen Ausblick auf daraus hervorgehende, weiterführende Forschungsfragen.

1 Theoretischer Hintergrund

1.1 Stationäre Altenpflege in Deutschland - Relevanz des Forschungsfeldes

In den letzten Jahren hat sich im Bereich der stationären Wohnformen mit pflegerischer Versorgung ein Wandel dahingehend vollzogen, dass Wohnformen mit ergänzenden Serviceleistungen, sog. Seniorenwohnheime, an Bedeutung verloren haben, wohingegen Einrichtungen für Personen mit hohem und komplexem Pflegeaufwand, sog. vollstationäre Pflegeheime, einen starken Zulauf verzeichneten (Wingenfeld, 2012). In der Gesellschaft sehen sich Pflegeheime nach wie vor widersprüchlichen, emotional teils aufgeladenen Betrachtungen ausgesetzt: Zum einen als verlust- und teilweise auch skandalbehaftete Institution vor dem Hintergrund einer Marginalisierung und Ausnutzung des Alters, verbunden mit erheblichen Mängeln und Abstrichen bei der Lebensqualität, die vom Großteil der Bevölkerung abgelehnt wird; zum anderen als jene „letzte Instanz“, die eine Versorgung von Individuen auch bei schwersten Einschränkungen und höchstem Pflegebedarf noch zu gewährleisten imstande ist (Lawton, 1986; Wahl & Schneekloth, 2009). Gerade in Letzterem liegt die Kernkompetenz der stationären Altenpflege, die aufgrund ihres besonderen Therapie- und Pflegepotenzials nicht ohne weiteres zu ersetzen ist und folglich besondere Relevanz besitzt (Wahl & Schneekloth, 2009). Dies spiegelt sich auch in den Zahlen zur vollstationären Langzeitversorgung von Pflegebedürftigen wider, nach denen in der Bundesrepublik Deutschland im Jahr 2013 743.430 Menschen (764.000 inkl. Kurzzeitpflege) in Pflegeheimen versorgt wurden, was einem Anteil von rund 29% aller Pflegebedürftigen entspricht (Statistisches Bundesamt, 2015). Trotz in der Bevölkerung vorherrschender Tendenzen, die häusliche der institutionellen Pflege vorzuziehen, ist die absolute Zahl der Pflegeheimbewohner seit 1999 um 35,8% und seit 2011 um weitere 2,9% gestiegen (Statistisches Bundesamt, 2015). Auch die Zahl der Pflegeeinrichtungen hat zugenommen: Allein zwischen 2011 und 2013 stieg ihre Anzahl in Deutschland um 5,5% auf rund 13.000, wovon rund 10.900 vollstationäre (Dauer-)Pflegeheime waren (Statistisches Bundesamt, 2015). Es wird überdies erwartet, dass aufgrund der nach wie vor steigenden Lebenserwartung die Zahl der Pflegebedürftigen in höher entwickelten Ländern weiter zunehmen wird, ungeachtet gegenwärtig im Fokus stehender Bemühungen von Politik und Wissenschaft zur

Anhebung der „Healthy Life Expectancy“ (gesunde Lebenserwartung) in der Bevölkerung (World Health Organization, 2012). Trotz der hohen Anzahl Pflegebedürftiger sehen sich Träger und Betreiber von Pflegeheimen mit der Aufgabe konfrontiert, in den Wettbewerb mit anderen Institutionen bzw. anderen Pflegeformen zu treten, um ihre Existenz zu sichern und gleichermaßen gegen ihr negatives Image anzukämpfen. Es werden neue Konzepte entworfen mit dem Ziel der Modernisierung und Weiterentwicklung des Wohn- und Lebensumfelds Pflegeheim und der Steigerung seiner gesellschaftlichen Akzeptanz als würdevoller letzter Heimstätte mit hoher Lebensqualität (BMFSFJ, 2006). Neben einer hohen Qualität in der Pflege, die hier im Idealfall als gegebener Standard gefordert werden kann, beinhaltet dies zunehmend auch therapeutische und Freizeitangebote, welche zu einem großen Teil in das Leistungsspektrum vollstationärer Altenpflege-einrichtungen Eingang gefunden haben (Schneekloth & von Törne, 2009). Dem hat auch der Gesetzgeber mittlerweile Rechnung getragen: Nach §5 SGB XI sollen Pflegekassen gemäß §71 Absatz 2 SGB XI Leistungen zur Prävention in stationären Pflegeeinrichtungen gewähren, mit dem Ziel der Stärkung der gesundheitlichen Situation und der Steigerung der gesundheitlichen Ressourcen und Fähigkeiten (siehe dazu auch den Leitfaden zur Prävention in stationären Pflegeeinrichtungen; GKV Spitzenverband, 2016). Überdies werden gemäß §87b SGB XI nun Vergütungszuschläge für zusätzliche Aktivierung in stationären Pflegeeinrichtungen gewährt. Dies scheint insbesondere vor dem Hintergrund einer durchschnittlichen Verweildauer von Bewohnern in Pflegeheimen von etwa bei 30 bis 40 Monaten (BMFSFJ, 2006) durchaus sinnvoll. Zu den Handlungsfeldern dieser Empfehlungen und Vorgaben gehört explizit auch die Aktivitäts- und Bewegungsförderung, die aufgrund ihrer hohen Relevanz für die vorliegende Dissertationsschrift weiter unten ausführlicher thematisiert wird.

1.2 Bewohner der stationären Altenpflege: Charakteristika und Besonderheiten

Der Einzug in ein Pflegeheim erfolgt in vielen Fällen im Anschluss an einen Kranken-hausaufenthalt oder den Verlust eines Ehepartners bzw. pflegenden Angehörigen (Stamm, Heusinger von Waldegg, & Jaeger, 2006). In der Regel erlauben es der körperliche und/oder kognitive Zustand sowie die soziale Situation und Wohnum-gebung einer hilfsbedürftigen Person nicht, in eigener Häuslichkeit zu verbleiben. Die

Versorgung des Betroffenen wird für ihn selbst bzw. für die pflegende Person eine zu große Belastung, die einen Einzug in ein Pflegeheim unumgänglich macht (Altmann, 2014; Mollenkopf, Oswald, Wahl, & Zimber, 2004). Erwartungsgemäß steigt mit zunehmendem Alter auch der Anteil der Pflegebedürftigen in der Bevölkerung an. Zwischen dem 70. und 75. Lebensjahr beträgt dieser Anteil nur ca. 5%, steigt für die Gruppe zwischen 80 und 85 Jahren auf 21% an und beträgt ab dem 90. Lebensjahr gar über 64% (Statistisches Bundesamt, 2015). Definiert nach Leistungsbezug aus der Pflegekasse ist dabei insbesondere ab dem 80. Lebensjahr der Anteil der pflegebedürftigen Frauen deutlich höher, als jener der Männer (Statistisches Bundesamt, 2015). Nicht zuletzt auch aufgrund der allgemein bekannten höheren Lebenserwartung von Frauen, stellen diese mit 73% die überwiegende Mehrheit in Pflegeheimen dar (Schneekloth & von Törne, 2009).

Nach §14 SGB XI wird unter dem Begriff Pflegebedürftigkeit die dauerhafte Hilfsbedürftigkeit von Menschen verstanden, die aufgrund einer körperlichen, geistigen oder seelischen Erkrankung oder Behinderung nicht selbstständig die regelmäßig notwendigen Tätigkeiten des täglichen Lebens ausführen können (Udsching, 2010). 98% der vollstationär versorgten Pflegebedürftigen sind einer Pflegestufe zugeordnet und beziehen Leistungen der Pflegeversicherung nach §14 SGB XI (Statistisches Bundesamt, 2014). Unterteilt nach Pflegestufe zeigt sich, dass im Jahr 2015 in Deutschland rund 38% der Bewohner der stationären Altenpflege in Pflegestufe I, rund 40% in Pflegestufe II und rund 21% in Pflegestufe III eingestuft wurden; lediglich etwas mehr als 1% der Bewohner hatte keine Pflegestufe (Statistisches Bundesamt, 2015). Nach wie vor sind kaum präzise Daten zur Morbidität von Pflegeheimbewohnern vorhanden, die genausten Daten stammen aus Diagnosestatistiken zur Feststellung von Pflegebedürftigkeit nach SGB XI (Wingenfeld, 2012). Hier präsentiert sich ein breites Spektrum an Erkrankungen, wobei insbesondere Demenz, aber auch weitere psychische, neurologische und Herz-Kreislauf-Erkrankungen sowie Erkrankungen des Muskel-Skelett-Systems den Großteil der Indikationen darstellen (Stamm et al., 2006; Wingenfeld, 2012). Das parallele Vorliegen mehrerer Erkrankungen (Multimorbidität) wie Demenz, Depression, Inkontinenz, sensorischen Einschränkungen und Mangelernährung sowie rezidivierende Stürze machen Pflegeheimbewohner zu einer Hochrisikogruppe, die immer wieder von Krankenhauseinweisungen bedroht ist (Stamm et al., 2006). Nach Angaben von Hallauer et al. weisen knapp 70% der Pflegeheimbewohner mittelgradige bis schwere Mobilitäts-

und Bewegungseinschränkungen auf, d.h. sie sind angewiesen auf einen Rollator (knapp 26%), auf einen Rollstuhl (30%), oder sie sind bettlägerig (13%) (Hallauer, Bienstein, Lehr, & Rönsch, 2005). Dabei gilt, dass kognitiv nicht und leicht eingeschränkte Bewohner seltener mobilitätseingeschränkt sind als jene mit starken kognitiven Einschränkungen (Kleina, Brause, Horn, Wingenfeld, & Schaeffer, 2012). Nicht nur im Hinblick auf die Betreuung und Versorgung stellt diese ausgeprägte Heterogenität der Bewohner besondere Anforderungen an die Versorgungsstrukturen. Sie verkompliziert auch die Suche nach geeigneten Interventionsmaßnahmen, die dem dieser Arbeit zugrunde liegenden Gedanken der Verbesserung der Lebensqualität und Gesundheit der Bewohner gerecht zu werden imstande sind. Zwar ergibt sich für Interventionsmaßnahmen, ebenso wie für die Versorgung, die Forderung nach spezieller Anpassung an jeden einzelnen Bewohner. Allerdings besteht für diese zusätzlich noch die Herausforderung, als übergreifende Maßnahme für alle Bewohner/-innen zugänglich und ebenso zielorientiert zu sein. Im LTCMo-Projekt wurde daher ein multidisziplinärer und mehrdimensionaler Ansatz mit Fokus auf individualisiertem, körperlichen Training der Bewohner und zusätzlicher Schulung von Pflegeheimmitarbeitern zur Förderung körperlich aktiven Verhaltens der Bewohner verfolgt.

1.3 Das Life-Space Konzept: Herkunft des Begriffs und Stand der Forschung

Gemäß der Zielsetzung des LTCMo-Projekts war in der vorliegenden Arbeit der Life-Space und dessen Nutzung von Pflegeheimbewohnern der Hauptendpunkt. Im Folgenden wird die Herkunft des Begriffs „Life-Space“ erläutert, sowie dessen existierende Konzeptualisierung und methodengestützte Erfassung im Allgemeinen und in der stationären Altenpflege im Speziellen dargestellt.

1.3.1 Herkunft und Definition des Begriffs

Der Begriff „Life-Space“ geht hervor aus dem Begriff „Lebensraum“, wurde jedoch erst später so bezeichnet. Der Lebensraum wurde bereits 1935 von mehreren Autoren thematisiert, u.a. im Kontext kindlicher Persönlichkeitsentwicklung (Lewin, 1935; Muchow & Muchow, 1935). Je nach Auslegung des Begriffs besteht ein unterschiedliches Verständnis von Lebensraum. Wie Kurt Lewin (1935) beschrieb, kann ein physisch identischer Lebensraum individuell unterschiedlich wahrgenom-

men werden, d.h. auch unterschiedliche Verhaltensweisen von Individuen hervorbringen, je nach Vorliegen unterschiedlicher motivationaler Komponenten (bspw. das Aufsuchen eines Parks um dort zu sitzen oder um dort sportlich aktiv zu sein). Diesem Gedanken folgend ist zu unterscheiden zwischen dem schwer zu erfassenden, subjektiv wahrgenommenen und dem objektiv messbaren, auf räumliche Ausdehnung bezogenen Lebensraum. Gleichwohl ist klar, dass diese beiden Konzepte miteinander verbunden sind, da einerseits die subjektive Wahrnehmung des Lebensraums dessen objektiv messbare Nutzung mitbestimmt, andererseits der objektiv vorhandene Lebensraum Objekte (Gegenstände, Personen, etc.) anbietet, welche die Wahrnehmung des Lebensraums beeinflussen.

Zunächst ist der Lebensraum (bspw. eines Neugeborenen) außerordentlich klein, wobei anhand der zunehmenden Erschließung des persönlichen Lebensraums die wechselseitige Beeinflussung von Individuum und Umwelt immer deutlicher hervortritt: Der heranwachsende Mensch lernt einerseits, mehr Kontrolle über seine Umwelt auszuüben; demgegenüber steht seine Abhängigkeit von einer immer größer werdenden Zahl an Umweltfaktoren (Lewin, 1935). Dies ist insofern bedeutsam für die vorliegende Arbeit, als dass zum einen beim alternden Menschen von einer entgegengesetzten Verlaufsrichtung dieser Person-Umwelt Konstellation ausgegangen werden kann (Pastalan, 1982). Zum anderen besteht eine große Schnittmenge zwischen Lewins hier gemachter Aussage und der für die Dissertation maßgeblichen Hypothese Lawtons zur Annahme von Veränderungen des Life-Space durch die im Projekt durchgeführte Intervention (siehe Kap. 1.5.1).

Zu Beginn der 60er Jahre nahm sich die Gerontologie des Themas Lebensraum unter häufigerer Verwendung des Begriffs „Life-Space“ an, woraus zahlreiche Arbeiten mit Blick auf den alternden bzw. alten Menschen hervorgingen. Neben dem „sozialen Life-Space“, welcher den Einfluss des Alterns auf die Interaktion mit anderen Personen betrachtete (Cumming & Henry, 1961), kam dem Wohnumfeld der Personen eine hervorgehobene Rolle zu, hauptsächlich im Rahmen von Arbeiten aus dem Bereich der eigenen Häuslichkeit (Rosow, 1967), aber bereits zu dieser Zeit auch zum Thema Institutionalisierung und Pflege (Lieberman, 1969).

Es existiert keine allgemein gültige Definition des Begriffs Life-Space, wohl auch aufgrund der Tatsache, dass der Begriff eine ausgeprägte Mehrdimensionalität besitzt (Graumann & Kruse, 1995). Aus Blickrichtung der Umweltpsychologie formulierte Pastalan Life-Space als einen Komplex bekannter, über den Raum

verteilter Objekte und Personen, die für das Individuum bedeutsame Funktionen besitzen oder zu denen eine besondere Beziehung besteht (Pastalan, 1982). Diese Definition hebt neben der räumlichen Umwelt auch die Verbindung von Life-Space mit der sozialen Umwelt hervor, die es auch als Maß für soziale Teilhabe bzw. Isolation geeignet erscheinen lässt (Fry & Keyes, 2010).

Sehr häufig wird eine weitere Begriffsbestimmung von May et al. (1985) als definitorischer Ausgangspunkt verwendet. Nach dieser mehr auf das räumliche Umfeld spezifizierten Definition, ist der Life-Space jenes Gebiet, durch welches sich ein Subjekt innerhalb eines definierten Zeitraums bewegt (May, Nayak, & Isaacs, 1985). Neuere Arbeiten zum Thema widersprechen sich dahingehend, dass manche Autoren den rein räumlichen Aspekt aufgeben und mit dem Begriff der Mobilität verschränken (Baker, Bodner, & Allman, 2003; Webber, Porter, & Menec, 2010), während andere widerum den rein räumlichen Aspekt unter Ausschluss der Mobilität beibehalten und den Life-Space unabhängig von der Art, wie man sich diesen erschließt, betrachten (Stalvey, Owsley, Sloane, & Ball, 1999). Dennoch nehmen mittlerweile die meisten Arbeiten den mobilitätsverbundenen Standpunkt ein und sprechen von „Life-Space Mobility“, d.h. sie nutzen den Life-Space in gewisser Weise als Maß für Mobilität. So ziehen z.B. Webber et al. (2010) Life-Space zur Definition von Mobilität heran, welche sie als die Fähigkeit sehen, sich innerhalb der eigenen Umwelt zu bewegen, die sich vom eigenen Haus bis zu weit entfernten Regionen (im Grunde dem Rest der Welt) erstreckt. Eine Einteilung des Life-Space erfolgte erstmals durch May et al. (1985) unter Zuhilfenahme konzentrisch um den kleinsten Lebensbereich streuender Zonen. Diese Vorgehensweise wurde in der Folge von anderen Autoren weitestgehend übernommen, wobei Anzahl und Definition der unterschiedlichen konzentrischen Zonen je nach eingesetztem Assessment unterschiedlich ausfielen. So teilten May et al. (1985) den Life-Space in fünf Zonen ein, ausgehend vom Schlafzimmer einer Person bis hin zum Bereich jenseits der nächsten verkehrsreichen Straße. Baker et al. (2003) definierten sechs Zonen, ebenfalls beginnend mit dem Schlafzimmer, jedoch endend mit dem Gebiet außerhalb der Stadt. Im Mobilitätsframework von Webber et al. (2010) wird der Life-Space in sieben Zonen unterteilt, mit einer Expansion vom Schlafzimmer bis zur „ganzen Welt“. Stalvey et al. (1999) lösten den Life-Space noch feiner auf: in neun Zonen, die vom Schlafzimmer als kleinste Zone bis hin zum Ausland als größte Zone reichten. Eine faktorenanalytische Untersuchung dieser Zonen wurde bisher nicht

vorgenommen, sodass eine deskriptive Beschreibung der Life-Space Zonen an dieser Stelle ausreichen soll. Auch wurden im Rahmen der oben genannten Arbeiten mehrere Messinstrumente für Life-Space bei in eigener Häuslichkeit lebenden Personen entwickelt, welche in Kap. 1.6 beschrieben werden.

1.3.2 Stand der Forschung

Der Großteil der Studien zum Thema Life-Space brachte querschnittliche Ergebnisse im Sinne von Assoziationen bestimmter Faktoren mit Life-Space hervor; nur selten wurde Life-Space in längsschnittlichen Untersuchungen berücksichtigt. Hinsichtlich des Life-Space von in eigener Häuslichkeit lebenden Älteren wurde gezeigt, dass dieser mit körperlicher Aktivität (Boyle, Buchman, Barnes, James, & Bennett, 2010; Portegijs, Tsai, Rantanen, & Rantakokko, 2015), körperlicher Leistungsfähigkeit (Baker et al., 2003; May et al., 1985; Tung et al., 2014), kognitiver Funktion (Barnes et al., 2007), Geschlecht und Rassenzugehörigkeit (Al Snih et al., 2012; Choi, O'Connor, Mingo, & Mezuk, 2016) und psychosozialen Faktoren wie Depressivität (Baker et al., 2003; Simmons, Schnelle, MacRae, & Ouslander, 1995; Tung et al., 2014), Sturzangst (Uemura et al., 2013) und Apathie (Tung et al., 2014) assoziiert ist. Es wurde zudem gezeigt, dass ein geringerer Life-Space mit einem höheren Risiko eines Pflegeheimeintritts verbunden ist (Fry & Keyes, 2010; Sheppard, Sawyer, Ritchie, Allman, & Brown, 2013) sowie signifikant zur Prädiktion kognitiver Verschlechterung beiträgt (Crowe et al., 2008; James, Boyle, Buchman, Barnes, & Bennett, 2011). Ansätze zur Veränderung des Life-Space sind sehr rar und produzierten bisher keine eindeutige Evidenz. Maki et al. (2012) konnten keine positiven Auswirkungen eines Walking-Programms auf den Life-Space ihrer Teilnehmer nachweisen, wohingegen Fairhall et al. (2012) infolge eines individualisierten Heimtrainings eine Steigerung subjektiv erfassten Life-Spaces fanden.

1.3.3 Life-Space in der stationären Altenpflege

Während das Thema Life-Space im Alter und bei in eigener Häuslichkeit lebenden Personen ausführlicher thematisiert wurde, existiert zum Life-Space von Pflegeheimbewohnern nur eine geringe empirische Datenbasis. Eine Vorreiterrolle unternahmen hier Tinetti und Ginter (1990), als sie die zuvor beschriebene Unterteilung des Life-Space in konzentrische Zonen (vgl. Kap. 1.3.2) erstmals auf das Pflegeheim anwandten. Sie definierten vier Zonen, die den gesamten Life-Space eines Pflegeheimbewohners umfassen: *(1)* den privaten Raum einer Person; *(2)* den

Wohnbereich, in dem sich das private Zimmer befindet; *(3)* den gesamten anderen Bereich außerhalb des Wohnbereichs, jedoch innerhalb des Gebäudes; *(4)* das Gebiet außerhalb des Pflegeheims, auf dessen weitere Ausdifferenzierung sie verzichteten.

Tinetti und Ginter (1990) benannten zudem Besonderheiten, denen Life-Space Nutzung im Pflegeheim im Vergleich zur „offenen“ Wohnumwelt unterliegt. Sie bezogen sich dabei auf die Limitierung und klarere Definition der Bereiche innerhalb des Pflegeheims: auf die „Sammelplätze“, welche für Gruppenaktivitäten oder Essen vorgesehen sind, auf die Anpassung des Lebensraums an die Bedürfnisse der Bewohner, aber auch auf die an die Bewohner gestellten Anforderungen durch die Pflege, sowie nicht zuletzt auf die besondere soziale Komponente inklusive des „Zusammenlebens“ mit Fremden und dem Personal. Desweiteren entwickelten sie auch das bisher einzige Life-Space Assessmentinstrument für die stationäre Pflege: den „Nursing Home Life-Space Diameter“ (NHLSD), welcher die Ausdehnung und Häufigkeit von Bewegung zu einem Summenscore zusammenfügt (Tinetti & Ginter, 1990). Der NHLSD bietet auch die Möglichkeit, die (Un-)Abhängigkeit der Bewegungsausführung mit einzubeziehen, was das Instrument sozusagen auf eine Erfassung des Life-Space unter Berücksichtigung der Mobilität erweitert. Sie fanden heraus, dass ein niedrigerer NHLSD-Score mit einem höheren Hilfsbedarf zur Ausführung von Alltagsaktivitäten verbunden ist.

Nach Kenntnis des Autors existiert bis dato lediglich eine Interventionsstudie, die im Pflegeheimsetting eine Methode zur Erfassung des Life-Space eingesetzt hat: Grönstedt et al. (2013) verfolgten ein ähnliches Ziel wie LTCMo mit ihrem Projekt, in dem sie mittels individuell abgestimmter Trainingsmaßnahmen eine Steigerung der körperlichen Aktivität der Bewohner anstrebten. Allerdings nutzte diese Studie den NHLSD als Maß für körperliche Aktivität anstatt als Maß für Life-Space; eine Thematisierung des Life-Space blieb völlig aus und dieser wurde auch in der Studienkonzeption nicht berücksichtigt. Aus diesem Grund kann Manuskript IV als erste Studie betrachtet werden, welche sich konzeptionell mit einer interventions-gesteuerten Veränderung des Life-Space auseinandergesetzt hat und zugleich eine sensorbasierte Erfassung dieses Endpunkts beinhaltet.

1.4 Körperliche Aktivität im Kontext stationärer Altenpflege

1.4.1 Begriffsbestimmung

Körperliche Aktivität wird definiert als von der Skelettmuskulatur ausgehende Bewegung, welche zu einem Anstieg des Energieverbrauchs führt (Caspersen, Powell, & Christenson, 1985). Demzufolge kann jedwede Form von Bewegung, unabhängig vom Kontext ihrer Entstehung, als „körperliche Aktivität" betrachtet werden. Im Rahmen der umfangreichen wissenschaftlichen Auseinandersetzung mit dem Thema körperliche Aktivität wird der Begriff zu einem großen Teil im Themenfeld Gesundheitssport verortet, meist im Zusammenhang mit „Aktivitätsförderung" bzw. „Bewegungsförderung". Positive Wirkungen sportlicher Aktivität auf zahlreiche Gesundheitsparameter sowie deren Assoziationen sind vielfach nachgewiesen und derart etabliert, dass führende Organisationen im Gesundheitssektor Empfehlungen dazu herausgegeben haben (Rütten, Abu-Omar, Lampert, & Ziese, 2005; U.S. Department of Health and Human Services, 1996; World Health Organization, 2010). Auf dieser Grundlage wird vor dem Hintergrund der thematischen Ausrichtung dieser Arbeit auf eine weitere Betrachtung der allgemein anerkannten Evidenz positiver Auswirkungen körperlicher Aktivität über die Lebensspanne verzichtet. Stattdessen soll körperliche Aktivität sowie diesbezügliche Evidenz ausschließlich in dem für die vorliegende Arbeit relevanten Kontext der stationären Altenpflege näher beleuchtet werden.

1.4.2 Stand der Forschung

Die körperliche Aktivität von Bewohnern der stationären Altenpflege ist, im Gegensatz zur Aktivität der in eigener Häuslichkeit lebenden Bevölkerung, ein schwer zu „bespielendes" Forschungsfeld. Aufgrund von fremdbestimmten, institutionellen Umwelteinflüssen, dem besonderen sozialen (Wohn-)Umfeld mit Mitbewohnern und Pflegeheimpersonal, zahlreichen vorhandenen Krankheitsbildern sowie damit verbundener Medikation, psychosozialen Besonderheiten wie bspw. Depressivität und Sturzangst, und nicht zuletzt aufgrund des zum Teil sehr hohen Alters der Bewohner ist Forschungsarbeit in dieser Population mit besonderen Herausforderungen verbunden. Daher überrascht es nicht, dass bisher nur wenige Studien Daten zur körperlichen Aktivität von Bewohnern der stationären Altenpflege geliefert haben, mit zum Teil sehr heterogener psychometrischer Qualität des Datenmaterials. Es zeigt sich, dass die körperliche Aktivität von Pflegeheim-

bewohnern im Vergleich zu in eigener Häuslichkeit lebenden älteren Menschen sehr gering ausgeprägt ist (Bates-Jensen et al., 2004; Den Ouden et al., 2015; MacRae et al., 1996). Der oftmals schlechte Gesundheitszustand der Teilnehmer, Sturz- und Verletzungsangst, Inaktivität im „früheren“ Leben und Unwissenheit über die positiven Auswirkungen körperlicher Aktivität sind häufige Ursachen für die Inaktivität von Pflegeheimbewohnern (Chen, 2010). Hinzu kommt der hohe Anteil an mittelgradig bis schwer mobilitätseingeschränkten Personen (vgl. Kap. 1.2). Zusätzlich zu intraindividuellen Barrieren wirken auf Pflegeheimbewohner weitere institutionelle Einflüsse, die oftmals aktivitätshemmend statt -fördernd sind. Dazu zählen das häufige Nichtvorhandensein bzw. die zu geringe Größe von Orten und Räumen zur Ausübung von Aktivität, ein Mangel an zuständigem Personal, unflexible tägliche Routinen, Sicherheitsbedenken sowie unzureichende Methoden und Standards um für Aktivitätsförderungsmaßnahmen in Frage kommende Bewohner zu identifizieren (Benjamin et al., 2011; Chen, 2010; Lazowski et al., 1999; MacDonald, 2006).

Die wesentlichen Ziele der Aktivitäts- und Bewegungsförderung von Pflegeheimbewohnern orientieren sich sehr stark an der Förderung von Mobilität und motorischer Funktion sowie dem damit verbundenen Erhalt eines möglichst hohen Maßes an Unabhängigkeit bei der Verrichtung wesentlicher Alltagsaktivitäten (Activities of Daily Living, ADL; Basic Activities of Daily Living, BADL) (Oswald, Ackermann, & Gunzelmann, 2006). Weitere wesentliche Ziele sind die Verbesserung der Lebensqualität, der kognitiven Funktion und sozialer Ressourcen. Life-Space wurde in diesem Feld bisher nicht als Endpunkt betrachtet.

Die Form, in der körperliche Aktivität bzw. Bewegung bisher meist appliziert wurde, ist den gerade genannten Zielen entsprechend das körperliche Training, welches in der Regel auf bestimmte, mit Mobilität und Funktion verbundene Endpunkte abgestimmt wurde (z.B. Balance und Kraft, Aufsteh- und Gehfähigkeit). Mittlerweile wurden in einigen Studien mit Pflegeheimbewohnern positive Effekte solcher körperlicher Trainingsinterventionen nachgewiesen: u.a. der Erhalt bzw. die Verbesserung der motorischen Funktion (Crocker et al., 2013; Lazowski et al., 1999; Shakeel, Newhouse, Malik, & Heckman, 2015; Weening-Dijksterhuis, de Greef, Scherder, Slaets, & van der Schans, 2011), der kognitiven Funktion (Tittlbach, Henken, Lautersack, & Bös, 2007), psychosozialer Faktoren (Singh, 2002), sowie eine Abschwächung des gesundheitlichen Abbaus (Shakeel et al., 2015), eine Verringerung

der Sturzhäufigkeit (Cameron et al., 2012) und Verhaltensauffälligkeiten (Eggermont & Scherder, 2006; Scherder, Bogen, Eggermont, Hamers, & Swaab, 2010).
Erfreulicherweise bieten inzwischen zahlreiche Pflegeheime Aktivitätsprogramme an, die jedoch leider viel zu häufig unspezifische „Trainings"-Übungen beinhalten und den Aspekt der psychosozialen Unterstützung vernachlässigen. Zudem sind sie hinsichtlich Intensität und Häufigkeit oftmals nicht auf die zum Teil sehr heterogene Teilnehmerschaft abgestimmt oder schließen gar schwerer eingeschränkte Personen aus (Horn, Brause, & Schaeffer, 2012). Eine umfassende Übersichtsarbeit dazu bieten Horn et al. (2013). Sie sehen zusätzlich zu den bereits oben aufgeführten Barrieren und Problemen bei der Implementierung solcher Programme auf Seiten der Teilnehmer und Institutionen auch Schwächen der Programme selbst als Hemmnisse für deren Erfolg. Wesentliche Probleme seien demnach die mangelnde wissenschaftliche Evaluation, Beschränkung auf spezifische Subgruppen anstatt einer breiten Auslegung auf ein Gros der Bewohnerschaft, sowie fehlende Angaben zu materiellen und personellen Voraussetzungen.

1.4.3 Körperliche Aktivität als Interventionsziel: Funktion versus Verhalten

Bei der Konzeption von Interventionen mit dem Ziel der Steigerung körperlicher Aktivität ist es wichtig zu unterscheiden zwischen motorischer Funktion, die in der Regel leistungsbasiert erfasst wird, und habitueller körperlicher Aktivität. Diese beiden Endpunkte stehen in reziproker Beziehung zueinander und sollten folglich nicht synonym verwendet werden. Im Gegensatz zur motorischen Funktion bzw. Leistung, die sozusagen im Sinne einer „Schnappschuss"-Aufnahme erfasst werden kann, ist habituelle körperliche Aktivität als *Verhalten* zu sehen, welches überdauernd im Alltag gezeigt wird. Hinzu kommt, dass die eindimensionale motorische Funktion nur einen Teilaspekt mehrdimensional entstehenden Verhaltens darstellt, welches bspw. durch kognitive Funktion und psychosoziale Faktoren (z.B. Motivation, Selbstwirksamkeit, etc.) beeinflusst wird. Demnach kann man körperliche Aktivität oder auch „körperlich aktives Verhalten" als der motorischen Funktion übergeordnet betrachten, sozusagen als eine wiederkehrende Vollführung zahlreicher, motorischer und funktioneller Leistungen im Alltag. Auf der anderen Seite kann körperlich aktives Verhalten eben nur dann ausgeübt werden, wenn die dafür erforderlichen motorischen Funktionen überhaupt erbracht werden können. Um folglich in einer Zielgruppe wie Pflegeheimbewohnern, mit all ihren zuvor genannten Einschrän-

kungen, eine Steigerung der habituellen körperlichen Aktivität zu erreichen, ist eine Fokussierung auf die Verbesserung motorischer Funktion bzw. Leistungsfähigkeit zwar absolut notwendig, jedoch sollte dies komplementiert werden durch Maßnahmen zur Verbesserung psychosozialer Faktoren.
Die Intervention im Rahmen des LTCMo-Projekts sollte daher auf zwei Wegen zu positiven Effekten auf die körperliche Aktivität führen:

- Durch trainingsinduzierte Verbesserungen der motorischen Funktion (im Sinne von „Competence“, siehe folgendes Kapitel 1.5.1), welche die Ausführung aktiveren Verhaltens ermöglichen bzw. eine erhöhte Sicherheit dabei bieten. Damit verbunden werden auch Verbesserungen psychosozialer Ressourcen, wie bspw. der Selbstwirksamkeit, erwartet.
- Durch die Förderung körperlich aktiven Verhaltens vonseiten des Pflegeheimpersonals infolge der Mitarbeiterschulungen, sodass das Personal körperliche Aktivität im Alltag fördert.
- Durch die Schulung von heimeigenen Mitarbeitern, welche das Training im Anschluss an die Studie eigenständig und nachhaltig weiterführen können.

Die theoretische Basis für diese Überlegungen, sowie die Grundlage für Annahmen zur Veränderung des Life-Space der Bewohner, werden im folgenden Kapitel erläutert. Gemäß der dort beschriebenen environmental docility hypothesis sowie der environmental proactivity hypothesis sollen die Bewohner durch die Interventionsteilnahme in die Lage versetzt werden, ihre Umwelt breiter zu nutzen, ihre Abhängigkeit von der Umwelt zu reduzieren sowie ihr Aktivitätsverhalten selbstbestimmter und sicherer auszuführen.

1.5 Modifikation von Life-Space mittels körperlichem Training

1.5.1 Verhaltensänderung vor dem Hintergrund umweltlich-institutioneller Gegebenheiten

Eine Veränderung des Verhaltens von Personen mit auf mehreren Ebenen eingeschränkten Fähigkeiten und Kompetenzen, stellt eine besondere Herausforderung dar. Insbesondere in einem Kollektiv wie Bewohnern der stationären Altenpflege ist Verhalten an Umweltfaktoren gekoppelt (Calkins, 2009). Ausgehend von den in Kapitel 1.3.1 dargestellten Überlegungen und Erkenntnissen der Umweltpsychologie wurde bereits vor einigen Jahrzehnten versucht, das Lebens- und

Wohnumfeld, d.h. die physische Umwelt, mit dem Verhalten von Personen in Verbindung zu bringen - ein Aspekt, der zuvor weitestgehend außer Acht gelassen wurde (Lawton, 1982). Daraus ging unter anderem das *Press-Competence Model* hervor (Lawton & Nahemow, 1973), welches aufgrund seiner Relevanz für die vorliegende Arbeit kurz erläutert wird. In dem Modell wird die abhängige Variable *Verhalten* als Funktion der *Competence* einer Person und dem gegebenen *Environmental Press* betrachtet, d.h. Verhalten wird als Funktion von verbliebenen Kompetenzen der Person (bspw. motorische Fertigkeiten, kognitive Ressourcen, körperliche Gesundheit, etc.) und den Anforderungen der Umwelt an die Person verstanden. Es verbildlicht die *Environmental Docility Hypothesis,* welche besagt, dass stark ausgeprägte Kompetenz mit geringerer Abhängigkeit von Umwelteinflüssen verbunden ist, wohingegen ein geringes Maß an Kompetenz gleichbedeutend ist mit einer größeren Abhängigkeit von der Umwelt (Lawton, 1970; Lawton & Simon, 1968). Diese Hypothese wurde später um die *Environmental Proactivity* ergänzt, welche die zuvor in der Environmental Docility Hypothesis implizierte, einseitige Wirkung der Umwelt auf die Person zu Gunsten einer wechselseitigen Interaktion von Person und Umwelt erweiterte, d.h. das Individuum nicht nur als Reakteur, sondern auch als Akteur betrachtete (Lawton, 1989). Nach dieser bedeutet eine Steigerung der Kompetenz einer Person, dass diese mit höherer Wahrscheinlichkeit in der Lage ist, sich innerhalb ihrer Umwelt ihrer Ziele und Bedürfnisse entsprechenden Ressourcen zu bedienen. Überträgt man diese beiden modellhaften Hypothesen auf die stationäre Altenpflege, so stellt der Einzug in ein Pflegeheim eine maximale Verringerung von Umweltanforderungen dar, da die Person kaum noch eigenständige Handlungen zu verrichten hat. Zudem sind die verbliebenen Fähigkeiten und Fertigkeiten der Bewohner zweifelsohne am untersten Rand des *Kompetenz*-Spektrums verortet, was auch die Möglichkeiten der Nutzung der in der Environmental Proactivity Hypothesis integrierten Ressourcen verringert. Kommt es nun allerdings, bspw. im Zuge von Programmen oder Interventionen wie des LTCMo-Projekts, zu einer Steigerung der individuellen Kompetenz, so kann davon ausgegangen werden, dass diese mit einer gesteigerten Nutzbarkeit der Umwelt und der vorhandenen Ressourcen einhergeht, sodass eine Erweiterung und umfangreichere Nutzung des persönlichen Life-Space erwartet werden kann.

1.5.2 Life-Space und körperliche Aktivität als bewegungsbezogene Verhaltensparameter

Vergleicht man die beiden bereits aufgeführten Definitionen von Life-Space (Kap. 1.3.1) und körperlicher Aktivität (Kap. 1.4.1), so beinhalten beide die „Bewegung“ als zentralen Begriff. Ebenso beziehen sich beide auf ausgeführtes Verhalten von Personen, nicht auf leistungsbezogene Faktoren. Eine adäquate Erfassungsmethode vorausgesetzt, erlauben beide Maße eine Evaluation von Trainings- bzw. Interventionseffekten auf Aktivitäts- und Bewegungsverhalten im Alltag. Während körperliche Aktivität unter der Prämisse der aktiven, eigenständigen Ausführung im Grunde als Synonym für Bewegung verwendet wird, bezieht sich der Life-Space auf den räumlichen Kontext und das Ausmaß des Raumes, innerhalb dessen Bewegung stattfindet. Dabei bleibt zunächst offen, ob diese Bewegung aktiv (bspw. Gehen) oder passiv (bspw.im Rollstuhl gefahren werden) erfolgt. Ein weiterer definitorischer Unterschied besteht in der Form der Bewegung: Körperliche Aktivität kann demnach Bewegungen beinhalten, welche an Ort und Stelle durchgeführt werden (bspw. Sitzgymnastik), wohingegen beim Life-Space nur solche Bewegung relevant und erfassbar ist, welche räumliche Veränderungen mit sich bringt (bspw. Gehen auf dem Flur). Bisher existieren keine Studien, welche den Zusammenhang von Life-Space und körperlicher Aktivität von Bewohnern der stationären Altenpflege untersucht haben. Studien mit zu Hause lebenden Älteren haben gezeigt, dass ein moderater Zusammenhang zwischen Life-Space und körperlicher Aktivität besteht (Boyle et al., 2010) und Personen an solchen Tagen körperlich aktiver waren, an denen sie einen größeren Life-Space aufwiesen (Portegijs et al., 2015). Ob eine kausale Verbindung zwischen diesen beiden Endpunkten besteht ist hingegen nach wie vor unklar.

1.6 Methoden zur Erfassung von Life-Space und Bewegungsverhalten

1.6.1 Erfassung von Life-Space im Rahmen des LTCMo-Projekts

Der Life-Space der Pflegeheimbewohner wurde im LTCMo-Projekt mittels eines kabellosen Sensornetzwerks, welches in beiden Pflegeheimen installiert wurde, im Sinne eines ambulanten Assessments objektiv erfasst. Dies stellt eine absolute Neuheit in der derzeitigen Forschungslandschaft dar, da keinerlei Studien existieren, die ein vergleichbares System zur simultanen Lokalisation mehrerer Personen in

Pflegeheimen eingesetzt haben. Die genutzte s-net® Technologie wurde vom Fraunhofer Institut für Integrierte Schaltungen entwickelt (Fraunhofer Institute for Integrated Circuits IIS; Wenzel, 2014), die Messdurchführung wurde von Mitarbeitern des Instituts begleitet. Die Technologie erlaubt es, die Bewohner innerhalb ihres eigenen Wohnumfelds durch am Körper getragene Sensoren „ökologisch valide“ zu erfassen. Eine ausführliche Beschreibung der technischen Grundlagen sowie deren Vor- und Nachteile erfolgt in Manuskript III, weswegen auf eine weiterführende Beschreibung zur Vermeidung von Redundanz an dieser Stelle verzichtet wird.

1.6.2 Gegenüberstellung und Diskussion von fragebogen- und sensorbasierten Erhebungsmethoden

Um die psychometrische Qualität der in der vorliegenden Arbeit erhobenen Life-Space Daten einordnen und nachvollziehen zu können, soll nachfolgend ein Überblick über bestehende Life-Space Assessmentverfahren und -instrumente gegeben werden. Zuvor werden die Vor- und Nachteile von fragebogen- und sensorbasierten Messmethoden im Allgemeinen, sowie bei multimorbiden älteren Kollektiven im Speziellen diskutiert

Es existiert eine Vielzahl an Methoden zur Erfassung habituellen Aktivitäts- und Bewegungsverhaltens. Gerade die Erfassung von Life-Space erfolgte meist mit subjektiven fragebogen-, tagebuch- und interviewgestützten Methoden sowie subjektiven Fremdratings („proxy ratings“). Die am häufigsten genutzten Instrumente für in eigener Häuslichkeit lebende Populationen sind das *University of Alabama at Birmingham Life-Space Assessment* (LSA; Baker et al., 2003), das *Life-Space Diary* (LSD; May et al., 1985)*, Life-Space Questionnaire* (LSQ; Stalvey et al., 1999), und seltener das *Life-Space Mobility at Home* assessment (LSH; Hashidate et al., 2013). Für das Pflegeheim wurde bisher lediglich der bereits erwähnte *Nursing Home Life-Space Diameter* (NHLSD; Tinetti & Ginter, 1990) entwickelt und eingesetzt.

Solche subjektiven Assessmentmethoden von Life-Space bzw. von Bewegung und Aktivität im Allgemeinen, sind durch die in ihnen enthaltene subjektive Einschätzung oftmals ungenau und wenig reliabel (Bussmann, Ebner-Priemer, & Fahrenberg, 2009; De Bruin, Hartmann, Uebelhart, Murer, & Zijlstra, 2008; Fahrenberg, Myrtek, Pawlik, & Perrez, 2007; Magaziner, Zimmerman, Gruber-Baldini, Hebel, & Fox, 1997). Dies gilt sowohl für selbst- als auch fremdauskunftbasierte Methoden. Zudem sind Fragebogeninstrumente häufig nicht speziell für den Einsatz in älteren

Populationen entwickelt (Jorstad-Stein et al., 2005). Problematisch ist auch, dass das Bewegungsverhalten älterer Personen oftmals von unregelmäßig oder selten stattfindenden Aktivitäten niedriger Intensität gekennzeichnet ist, welche zum Teil schwer erinnerbar sind (Hauer et al., 2011; Kaye et al., 2011) und sog. „floor-Effekte“ bei der Erhebung produzieren können (Tudor-Locke & Myers, 2001). Hinzu kommen Faktoren wie Multimorbidität, kognitive Einschränkungen und soziale Erwünschtheit, die zu Verzerrungen bei der Erinnerung und Wiedergabe von Aktivitäten führen können (Crowe et al., 2008; Harada, Chiu, King, & Stewart, 2001; Hauer et al., 2011; Matthews, 2002; Rikli, 2000). Ebenso ist es solchen Methoden nicht möglich, individuelle Veränderungen im Aktivitäts- und Bewegungsverhalten zeitlich präzise und mit hoher ökologischer Validität darzustellen (Kaye et al., 2011). Gerade dies ist aber in gerontologischer wie geriatrischer Forschung von enormer Wichtigkeit, insbesondere um die Effektivität und den Erfolg rehabilitativer oder präventiver Maßnahmen evaluieren zu können. Positiv ist zu erwähnen, dass solcherlei subjektive Erfassungsmethoden deutlich praktikabler als sensorbasierte Verfahren sind und der finanzielle und personelle Aufwand meist gering ist. Ein weiterer Vorteil ist, dass derlei Methoden zur Erhebung zusätzlicher, kontextbezogener, qualitativer Informationen geeignet sind, was bei technisch-objektiven Messungen bisher kaum möglich ist (Brose & Ebner-Priemer, 2015; Moschny, 2012).

Aus den genannten Gründen ist es mittlerweile wissenschaftlicher Alltag, dass in den Anwendungsfeldern der Sozialwissenschaften auch technik- bzw. computergestützte Systeme ambulant, je nach Zielsetzung auch im eigenen Wohnumfeld, eingesetzt werden, um Daten über das Befinden, Verhalten oder körperliche Parameter bzw. Aktivität von Personen zu erhalten (Fahrenberg, Leonhart, & Foerster, 2002; Kaye et al., 2011). Unter „ambulantem Assessment“ wird die Verwendung feldtauglicher, heutzutage meist computergestützter Erhebungsmethoden verstanden, mit denen Selbstberichte, Verhaltensbeobachtungen, psychometrische und physiologische Daten sowie Kontextbedingungen im alltäglichen Leben der Probanden erfasst werden können (Reuschenbach & Funke, 2011). Dies verspricht eine möglichst geringe methodenbedingte Reaktivität sowie eine hohe empirische Gültigkeit und Nützlichkeit (Fahrenberg et al., 2002). Die fortschreitende technische Entwicklung im Sinne einer zunehmendem Miniaturisierung bei sinkenden Kosten und die Weiter-entwicklung drahtloser Übertragungs- und Speicherungsmöglichkeiten hat zahlreiche Methoden hervorgebracht, die sich zur objektiven Erfassung von Bewegungs-

verhalten eignen. Dieser Endpunkt ist aufgrund seiner Multidimensionalität sehr komplex zu erfassen, sodass die Wahl der Methode unter Berücksichtigung der Genauigkeit und Machbarkeit („feasibility“) wohlüberlegt und gut begründet sein muss (Warren et al., 2010). Die am häufigsten eingesetzten, objektiven Methoden zur Erfassung von Life-Space sind „global positioning“ Systeme (kurz: GPS) für Outdoor-Aufzeichnungen, und Bluetooth Transmitter, Infrarot-Sensoren sowie „radio-frequency identification“-Systeme (kurz: RFID) für Indoor-Aufzeichnungen (Schenk et al., 2011; Thielke et al., 2014; Tung et al., 2014).

Wie die auf subjektiver Auskunft basierenden Methoden haben auch objektive Messmethoden Schwächen, die bei der Auswahl der richtigen Methode berücksichtigt werden müssen. Die Erfassung des Life-Space mittels GPS beispielsweise ist aufgrund des schlechten Empfangs nicht für den Einsatz in Gebäuden geeignet; eine hohe Genauigkeit von Bluetooth-, Infrarot- und RFID-Messungen ist nur bei einer hohen Sensordichte gewährleistet, was mit hohen Kosten für die Sensorinfrastruktur verbunden ist. Am Körper getragene Sensoren (sog. „body-worn sensors“) können je nach Platzierung zudem als störend und unangenehm empfunden werden.

2 Fragestellungen und Ziele

Aufgrund der Fokussierung des LTCMo-Projekts auf die Modifikation von Bewegungsverhalten, mit dem Hauptziel der interventionsbasierten Steigerung habitueller körperlicher Aktivität, wurde zunächst eine systematische Übersichtsarbeit erstellt (*Manuskript I*), die für das zugrundeliegende Projekt von wegweisender Relevanz war. Sie diente dazu, einen Überblick über das Forschungsfeld insgesamt, über durchgeführte Interventionen inklusive dadurch erzielter Effekte, sowie über eingesetzte Methoden zur Erfassung körperlicher Aktivität zu erhalten um wertvolle Handlungsempfehlungen für LTCMo abzuleiten und methodische Schwierigkeiten vorab zu identifizieren.

Darauf aufbauend erfolgte die endgültige Festlegung der zuvor bereits in Teilen feststehenden Studien- und Interventionskonzeption sowie der einzusetzenden fragebogen- und sensorbasierten Erhebungsmethoden. Auf dieser Grundlage wurde ein ausführliches Studienprotokoll erstellt (*Manuskript II*).

Da es bis dato zum Life-Space von Pflegeheimbewohnern weder deskriptive Daten gab, noch Analysen zu damit assoziierten Faktoren in dieser Zielgruppe, diente *Manuskript III* dazu, diese Forschungslücke zu schließen. Die dazu eingesetzte innovative, sensorbasierte Assessmentmethode ermöglichte eine objektive Darstellung des Life-Space der Bewohner. Aufgrund deren erstmaligen Einsatzes diente Manuskript III unter anderem zur ausführlichen Beschreibung dieser Methode.

Vor dem Hintergrund der in Kap. 1.5.1 dargestellten Verhaltensmodelle aus der Umweltpsychologie wurde im LTCMo-Projekt die Hypothese aufgestellt, dass in einem stark von der (institutionellen) Umwelt abhängigen Kollektiv wie Pflegeheimbewohnern eine interventionsinduzierte Steigerung der körperlichen Aktivität, motorischen Funktion und psychosozialer Ressourcen einhergeht mit einer Erweiterung und umfangreicheren Nutzung des individuellen Life-Space der Bewohner. Daher erfolgte in *Manuskript IV* die Überprüfung der Interventionseffekte auf den Life-Space und dessen Nutzung durch die Bewohner. Damit verbunden war auch eine Evaluation des Implementierungserfolgs zum Follow-Up nach drei Monaten.

Manuskript V kam der Forderung des innovAge-Projekts nach, dessen wissenschaftliche Teilprojekte (in diesem Fall LTCMo) für die praktische Anwendung durch „Nicht-Wissenschaftler“ umsetzbar zu machen („putting research into practice“). Im Sinne eines Handbuchs diente die Publikation einer für Endnutzer nachvollziehbaren, gut

verständlichen Dissemination der Projektinhalte zur Umsetzung in weiteren, studienunabhängigen Institutionen.

Nachfolgend werden die Kernfragestellungen der Dissertation zusammengefasst dargestellt[2]:

- Gibt es Interventionsstudien mit Pflegeheimbewohnern, die körperliche Aktivität als primären Endpunkt betrachtet haben? (*Manuskript I*)
- Welche Interventionen zeigten positive Effekte auf körperliche Aktivität? (*Manuskript I*)
- Wie ist der Life-Space von Bewohnern der stationären Altenpflege ausgeprägt? (*Manuskript III*)
- Mit welchen Faktoren ist der Life-Space von Pflegeheimbewohnern assoziiert und welche Rolle kommt dabei dem institutionellen Wohnumfeld zu? (*Manuskript III*)
- Führt ein mehrdimensionaler Interventionsansatz mit Schwerpunkt auf individualisiertem körperlichen Training zu einer Veränderung der Life-Space Nutzung von Bewohnern der stationären Altenpflege? (*Manuskript IV*)
- Bleiben Interventionseffekte auf Life-Space Parameter nach dreimonatigem Follow-Up und zwischenzeitlicher autonomer Weiterführung der Interventionsmaßnahmen durch Pflegeheimpersonal bestehen? (*Manuskript IV*)

Die einzelnen Manuskripte werden nachfolgend in Kapitel 3 nochmals unter Berücksichtigung einer gängigen Abstract-Gliederung zusammengefasst. Die Originaldokumente befinden sich im Anhang.

[2] Die hier aufgelisteten Fragestellungen beziehen sich lediglich auf die empirisch überprüfbaren Anteile der Dissertation. In den Manuskripten II und V wurden keine Fragestellungen untersucht, weswegen sie in der dazuhegörigen Auflistung der Fragestellungen nicht enthalten sind. Die Ziele dieser beiden Arbeiten werden im vorhergehenden Absatz genannt.

3 Publikationsübersicht und Zusammenfassungen

3.1 Manuskript I. Effects of Interventions on Physical Activity in Nursing Home Residents

Jansen, C.-P., Claßen, K., Wahl, H.-W., & Hauer, K. (2015). Effects of interventions on physical activity in nursing home residents. *European Journal of Ageing*, *12* (3), 261-271. doi: 10.1007/s10433-015-0344-1

Hintergrund und Zielsetzung

Bewohner der stationären Altenpflege stellen nach wie vor eine große Gruppe dar, die allerdings trotz ihrer großen Zahl in manchen Bereichen der Forschung kaum berücksichtigt wird. Insbesondere im Bereich sportwissenschaftlicher Forschung war diese Zielgruppe lange außen vor, bis der Fokus in den letzten Jahren auch sie erreichte. Dieser Entwicklung geht die Erkenntnis voran, dass auch für institutionalisierte Senioren die Aufrechterhaltung oder gar Steigerung der körperlichen Aktivität eine wesentliche Stellschraube zur Verbesserung der Gesundheit darstellen kann (Crocker et al., 2013; Hillsdon, Foster, & Thorogood, 2005). Die Realität zeigt allerdings, dass Pflegeheimbewohner im Vergleich zu nicht-institutionalisierten Senioren besonders inaktiv sind (Bates-Jensen et al., 2004; Scherder et al., 2010). Sie sind im Vergleich zu in eigener Häuslichkeit lebenden Älteren besonderen Umständen ausgesetzt und weisen individuelle Defizite auf, die in vielen Fällen auch der Grund für den Einzug in ein Pflegeheim sind. Dennoch existieren mittlerweile zahlreiche Studien die gezeigt haben, dass auch mit dieser Zielgruppe ein körperliches Training möglich ist und funktionelle Verbesserungen zu erzielen sind (Horn, Kleina, Vogt, Koch, & Schaffer, 2013). Vor diesem Hintergrund wurde eine systematische Übersichtsarbeit erstellt, die für das zugrundeliegende Projekt, LTCMo, von wegweisender Relevanz war. Sie diente dazu, einen Überblick über das Forschungsfeld zu erhalten und betreffende Studien hinsichtlich ihrer Qualität zu bewerten. Dazu wurden Interventionsstudien identifiziert, welche quantitativ erfasste körperliche Aktivität von Pflegeheimbewohnern als Endpunkt untersucht haben. Die Interventionen sollten hinsichtlich ihrer Durchführbarkeit und ihres Effekts auf körperliche Aktivität evaluiert werden. Die Art und Methoden der Erfassung der körperlichen Aktivität wurde einer umfangreichen Überprüfung und Evaluation

unterzogen um daraus evidenzbasierte, für das eigene Projekt wertvolle Handlungsempfehlungen abzuleiten und methodische Schwierigkeiten vorab zu identifizieren.

Methoden

Deutsch- und englischsprachige Literatur wurde in den folgenden, einschlägigen Literaturdatenbanken extensiv und systematisch gesucht: Cochrane Central Register of Controlled Trials (The Cochrane Library 2015, Issue 1), PubMed, CINAHL, PsycInfo, Psycarticles, Psyndex, Web of Knowledge, CC Med und DissOnline. Dabei kamen auch suchportalspezifische Thesauri und sogenannte „MeSH-Terms“ zum Einsatz, um eine bestmögliche Trefferzahl zu erreichen. Um in der Übersichtsarbeit berücksichtig zu werden, mussten Studien ein RCT-Design aufweisen, körperliche Aktivität als Endpunkt erfasst haben und im Pflegeheim mit Bewohnern über 65 Jahren durchgeführt worden sein. Nichterfüllung von mindestens einem dieser Einschlusskriterien führte zum Ausschluss aus der Übersichtsarbeit. Alle eingeschlossenen Studien wurden anhand eines etablierten Bewertungsschemas für RCTs der „Cochrane Bone, Joint, and Muscle Trauma Group“ (Latham et al., 2003) kritisch evaluiert. Sofern die Informationen in den Studien es ermöglichten, wurden zusätzlich Effektstärken der Interventionseffekte berechnet.

Ergebnisse

Ein sehr wesentliches Ergebnis war, dass lediglich acht Studien die Einschlusskriterien erfüllten und nur eine Studie körperliche Aktivität als primären Endpunkt betrachtete. Der Streubereich der Studienqualität zeigte, dass alle Studien mindestens die Hälfte der Höchstpunktzahl erreichten, wobei die am höchsten bewertete Studie 83% der erforderlichen Kriterien erfüllte. Zahlreiche Studien wiesen methodische Schwächen hinsichtlich der statistischen Auswertung und der Randomisierungsverfahren auf. Die Studien waren sehr heterogen in der Auswahl der Teilnehmer: Zum Teil wurden kognitiv eingeschränkte Personen grundsätzlich ausgeschlossen, meist jedoch bis zu einem Grenzwert äquivalent zu moderater kognitiver Einschränkung zugelassen. Mehrere Studien schlossen körperlich eingeschränkte Teilnehmer aus, wobei in nahezu allen Studien Teilnehmer ein hohes Risiko körperlicher Einschränkungen aufwiesen. Obwohl die meisten Studien körperliche Trainingsinterventionen nutzten, unterschieden sich diese stark in ihrer Zielausrichtung auf unterschiedliche motorische Fähigkeiten und Fertigkeiten (Ausdauer- vs. Kraft- vs. Funktionstraining) sowie in den Modalitäten der Durch-

führung. In den meisten Fällen waren die Interventionen mehrdimensonal ausgerichtet, d.h. sie wurden mit weiteren Inhalten gekoppelt, die ihren Schwerpunkt in pflegerischen oder auf Körperhygiene der Bewohner ausgerichteten Maßnahmen wie bspw. eigenständigen Toilettengängen hatten.
Die Ergebnisse zeigen, dass in sechs von acht Studien eine signifikante Steigerung der körperlichen Aktivität der Interventionsgruppen im Vergleich zu den Kontrollgruppen erzielt wurde. Mit einer Ausnahme beinhalteten alle Studien eine Form des körperlichen Trainings. Die Auswirkungen der Interventionen auf die körperliche Aktivität zeigten keine Abhängigkeit von der Studienqualität. Körperliche Aktivität wurde unter Einsatz von Aktivitätssensoren, Beobachtungen oder Fragebögen erfasst, deren psychometrische Qualität in den meisten Studien unzureichend dokumentiert wurde. Vier verschiedene Aktivitätssensoren wurden genutzt, die entweder an Knöchel, Oberschenkel oder Hüfte getragen wurden und deren Datenausgaben Informationen zu „movement counts“ (d.h., Ausschläge der Akzelerometer), Energieverbrauch oder der Dauer, über die eine bestimmte Aktivität verrichtet wurde, beinhalteten. Tiefergehende, verhaltensorientierte Informationen zu Schritten oder Bewegungsklassifikationen wie Liegen, Sitzen, (Auf-)Stehen oder Gehen waren darin nicht enthalten.

Diskussion

Diese Arbeit bietet erstmals einen systematischen Überblick über Interventionsstudien mit Pflegeheimbewohnern, welche eine quantitative Erfassung körperlicher Aktivität beinhalten. Die trotz umfassender Literatursuche geringe Zahl identifizierter Studien zeigt den Mangel an qualitativ hochwertigen Interventionsstudien, die körperliche Aktivität von Pflegeheimbewohnern zielgerichtet erfasst haben. Leider ließ die geringe Anzahl an Studien keine übergreifende statistische Analyse der Ergebnisse zu. Dennoch deuten die Ergebnisse darauf hin, dass eine Steigerung der körperlichen Aktivität von Pflegeheimbewohnern möglich ist, insbesondere wenn Trainingsinterventionen unter Berücksichtigung von psychosozialen und Verhaltensaspekten eingesetzt wurden, die zudem das Pflegeheimpersonal miteinbezogen. Diese Interpretation wird dadurch gestärkt, dass nahezu alle Interventionen einen solchen Effekt erzielten, obwohl sie nicht primär auf eine Steigerung der körperlichen Aktivität ausgerichtet waren. Positive Trainingseffekte waren zudem nicht auf bestimmte Subgruppen beschränkt, sodass angenommen werden kann, dass sowohl körperlich

als auch kognitiv eingeschränkte Pflegeheimbewohner von Maßnahmen der Aktivitätsförderung profitieren können. Einschränkend ist zu sagen, dass die Ergebnisse auf zum Teil nur unzureichend validierten Methoden basieren und nahezu alle genannten Messverfahren lediglich eine sehr oberflächliche Betrachtung der körperlichen Aktivität erlauben.

3.2 Manuskript II. Assessing the Effect of a Physical Activity Intervention in a Nursing Home Ecology: A Natural Lab Approach

Jansen, C.-P., Claßen, K., Hauer, K., Diegelmann, M. & Wahl, H.-W. (2014). Assessing the effect of a physical activity intervention in a nursing home ecology: a natural lab approach. *BMC Geriatrics,* 14: 117. doi: 10.1186/1471-2318-14-117

Hintegrund und Zielsetzung

Das LTCMo-Projekt wurde, gemäß der in der „innovAge“-Projektausschreibung der Europäischen Kommission formulierten Zielvorgaben, in erster Linie als Modellprojekt zur Umsetzung einer „sozialen Innovation“ mit hohem Potential für eine nachhaltige Implementierung konzipiert. Grundgedanke war daher, eine im Rahmen der Projektressourcen größtmögliche Anzahl an Pflegeheimbewohnern in die Studie zu integrieren und an der „sozialen Innovation“ teilhaben zu lassen. Dennoch war es erklärtes Ziel der Projektverantwortlichen, im Sinne eines „natural labs“ einen forschungsorientierten Ansatz mit hoher ökologischer Validität zu wählen, damit die Ergebnisse des LTCMo-Projekts wissenschaftlich analysiert und evaluiert werden konnten. Zwar erlaubte der inklusive Charakter des Projekts nicht die Konzeption der Studie als RCT, trotzdem sollte LTCMo den Kriterien des für diese Studien maßgeblichen „CONSORT“-Statements (Altman et al., 2001; Moher et al., 2010) in höchstmöglichem Maße folgen. Die wesentlichen Merkmale des LTCMo-Projekts sollten daher im Rahmen von Manuskript II als Studienprotokoll klar dargestellt und erörtert werden.

Der Aufbau eines Studienprotokolls orientiert sich an dem empirischer Artikel. Die Methoden stellen allerdings den Hauptteil eines solchen Protokolls dar und werden in der Diskussion einer kritischen Betrachtung unterzogen, Ergebnisse werden nicht dargestellt. Dieser Ordnung folgend wird zu Manuskript II nachfolgend kein gesonderter Ergebnisteil aufgeführt.

Methoden

In LTCMo wurde ein hochindividualisierter, mehrdimensionaler Interventionsansatz zur Steigerung der körperlichen Aktivität von Pflegeheimbewohnern verfolgt, der sich sowohl an die Bewohner selbst als auch an das in den beiden teilnehmenden Institutionen arbeitende Personal richtete.[3] Basierend auf ihrer individuellen motorischen Funktion wurden Bewohner zugeteilt zu (1) zwei Mal wöchentlich stattfindenden Gruppentrainings à 45 Minuten, mit maximal acht Teilnehmern und unterschiedlichen motorischen Fähigkeitsanforderungen, oder zu (2) Einzeltrainings à 30 Minuten für nicht gehfähige Bewohner (2). Auf code-gesicherten Wohnbereichen für verhaltensauffällige, kognitiv stark eingeschränkte Bewohner wurden gesonderte Gruppen durchgeführt, die inhaltlich jenen in den offenen Wohnbereichen entsprachen. Allen gehfähigen Bewohnern wurde zusätzlich einmal wöchentlich die Teilnahme an einem virtuellen Funktionstraining („Serious Game“) angeboten (3).
Das Studiendesign orientierte sich an dem parallelisierter Gruppenvergleiche ohne Randomisierung der Teilnehmer in Interventions- oder Kontrollgruppe. Jedem, der an der Intervention teilnehmen wollte, wurde dies gewährt, unter der Voraussetzung, dass alle Einschlusskriterien bzw. keine Ausschlusskriterien erfüllt waren. Es galten als Einschlusskriterien das Wohnen in einem der beiden Studien-Pflegeheime im Rahmen einer Langzeitpflege sowie die schriftliche Zustimmung zur Teilnahme durch den Bewohner oder dessen gesetzlichen Vertreter/Betreuungsperson. Je nach motorischer Einschränkung des Bewohners wurde er in eine der oben beschriebenen Interventionsgruppen zugeteilt. Ausgeschlossen von der Teilnahme wurden Bewohner, die zur Kurzzeitpflege eingezogen waren, palliativ versorgt wurden oder derart ausgeprägte Verhaltensauffälligkeiten aufwiesen, dass eine gefahrenlose Interaktion mit ihnen nicht sicher gewährleistet werden konnte.
Primäre Studienendpunkte der Untersuchung waren die sensor-basiert erfasste körperliche Aktivität und der Life-Space der Pflegeheimbewohner. Sekundäre Studienendpunkte waren psychosoziale, motorische und funktionelle Parameter, die anhand von Bewohnerinterviews, Proxybefragungen und motorischer Testverfahren erhoben wurden. Datenerhebungen wurden in beiden Institutionen vor und nach der Interventionsphase vorgenommen, sowie nach weiteren drei Monaten (Follow-up Messung).

[3] Das Pflegeheimpersonal wurde zu Kompetenzschulungen eingeladen, die einmal wöchentlich stattfanden und auf die Vermittlung von Kompetenzen und Techniken abzielten, die das Personal zur Motivation und Hilfe bei der Steigerung der körperlichen Aktivität seitens der Bewohner nutzen konnten.

Aufgrund zeitlicher Ressourcen konnte nur in einem der beiden Pflegeheime eine sog. „run-in“ Messung drei Monate vor Interventionsbeginn durchgeführt werden.

Diskussion

Körperliches Training hat sich in zahlreichen Studien als erfolgreiches Mittel zur Eindämmung oder gar Reversion motorisch-funktioneller Einbußen, zur Autonomiebewahrung sowie zur Verbesserung psychosozialer Ressourcen bewährt. Am häufigsten kam die Organisationsform Gruppentraining zum Einsatz (Crocker et al., 2013; Horn et al., 2013), Teilnehmer wurden in der Regel in diese Trainingsgruppen randomisiert. Dieser Ansatz konnte in der LTCMo-Studie durch deren Abweichung vom RCT-Protokoll deutlich individualisierter und stärker auf die einzelnen Teilnehmer zentriert verfolgt werden, da Teilnehmer ihrer motorischen Funktion entsprechend in Trainingsgruppen mit unterschiedlichen Fähigkeitsanforderungen zugeteilt wurden. Die Bandbreite der für eine Teilnahme geeigneten Bewohner war dadurch deutlich größer und wurde noch erweitert durch individuelle Einzeltrainings für jene, die aufgrund ihres schlechten motorischen und/oder kognitiven Status nicht für eine Gruppenteilnahme geeignet waren. Zudem sollten mit dem Angebot eines virtuellen Trainings weitere Bewohner angesprochen werden, die mit „konventionellen“ Trainingsformen nicht zu einer Teilnahme zu bewegen waren. Dem erklärten Ziel von LTCMo, möglichst viele Bewohner sozusagen „in Bewegung zu bringen“, konnte so in bestmöglichem Maße nachgekommen werden.

Hinsichtlich der Datenerfassung wurde in LTCMo ein umfassendes Assessmentprotokoll umgesetzt, das einerseits eine hoch-technisierte Erfassung des Life-Space und der körperlichen Aktivität der Bewohner erlaubte, andererseits auch auf etablierte motorische Tests für Bewohner sowie Interview- und Fragebogenverfahren zurückgriff, die sowohl mit Bewohnern als auch deren „Proxies“ (in diesem Fall Mitglieder der sozialen Betreuung) durchgeführt wurden.

Das Studiendesign wurde so abgestimmt, dass in beiden Pflegeheimen zeitversetzt exakt der gleiche Ablauf gewähreistet war (siehe Figure 2, Manuskript II). Durch pre- und post-Messung sollte der Interventionseffekt gezeigt und in der Follow-up Messung der weitere Verlauf dokumentiert werden. Ergänzt wurde dies durch eine zusätzliche „run-in“ Messung im zweiten Pflegeheim, welche den natürlichen Verlauf abbilden sollte. Mit diesem Design sollte in höchstmöglichem Maße wissenschaftlichen Ansprüchen Genüge getragen werden, insbesondere vor dem Hintergrund des

„non-RCT“-Designs. Durch Schulung der Mitarbeiter der sozialen Betreuung mit dem Ziel der eigenständigen Durchführung der Interventionskomponenten nach Ende der Interventionsphase, sollte die nachhaltige Etablierung des Programms in den Einrichtungen gesichert werden.

3.3 Manuskript III. Life-Space and Movement Behavior in Nursing Home Residents: Results of a New Sensor-based Assessment and Associated Factors

Jansen, C.-P., Diegelmann, M., Schnabel, E.-L., Wahl, H.-W., & Hauer, K. (2017). Life-Space and movement behavior in nursing home residents: results of a new sensor-based assessment and associated factors. *BMC Geriatrics*, 17: 36. doi: 10.1186/s12877-017-0430-7

Hintergrund und Zielsetzung

Bisher existieren nur sehr wenige Studien zum Life-Space von Pflegeheimbewohnern. Wissenschaftliche Untersuchungen fanden bisher mehrheitlich mit in eigener Häuslichkeit lebenden Älteren statt. Die wenigen Studien, die mit Pflegeheimbewohnern durchgeführt wurden, basierten auf Life-Space Daten, welche anhand von Fragebögen retrospektiv erhoben wurden. Solche Erhebungsmethoden sind insbesondere bei Kollektiven mit teils erheblichen kognitiven Einschränkungen problembehaftet und häufig systematisch verzerrt. Aus diesem Grund wurde in LTCMo ein kabelloses Sensornetzwerk des Fraunhofer Instituts für integrative Schaltungen eingesetzt, das sogenannte s-net®. Die Querschnittsdatenanalyse ist Gegenstand der Untersuchung in Manuskript III und zielt darauf ab, (1) erstmals eine objektive Deskription des Life-Space von Pflegeheimbewohnern zu präsentieren; (2) zu überprüfen, ob jene Determinanten, welche im bisher einzigen, im Forschungsbereich anwendbaren Modell zu „Life-Space Mobilität“ von zu Hause lebenden Älteren genannt werden (Webber et al., 2010), auch im Pflegeheimkontext Gültigkeit besitzen; (3) den Anteil zu bestimmen, welchen die „Umwelt Pflegeheim“ an der Life-Space Nutzung der Pflegeheimbewohner hat.

Methoden

Die Querschnittsdatenanalyse bezieht sich auf den Life-Space der Studienteilnehmer zur Baseline. Es wurden nur Daten jener Bewohner herangezogen, die zwei volle Tage an der Erhebung teilgenommen hatten. Dazu wurden die Daten aller Teilnehmer zwischen 10:00 und 18:00 in die Analyse einbezogen, um eine vergleichbare Datenstruktur zu gewährleisten. Der Einteilung von Tinetti und Ginter (1990) folgend wurde der Lebensraum Pflegeheim in die vier Zonen „privates Zimmer“, „Wohnbereich, auf dem die Person lebt“, „restliches Gebäude, innerhalb“ und „außerhalb des Gebäudes“ eingeteilt. Es wurden zwei wesentliche Parameter aus den Rohdaten entwickelt: die Zeit, die der Bewohner außerhalb des eigenen Zimmers verbringt („time away from room“ = TAFR) und die Wechselhäufigkeit zwischen den oben genannten Zonen („Transits“). Zur Überprüfung der Gültigkeit des zugrundeliegenden Modells von Webber et al. (2010) wurden lineare Regressionen auf die beiden Parameter TAFR und Transits gerechnet. Unter der Prämisse einer bivariaten Korrelation mit der jeweiligen Kriteriumsvariable von r bzw. $rho > .20$ und $p < .10$, flossene jene im Rahmen von LTCMo erfassten Parameter in die Modelle mit ein, die den von Webber et al. beschriebenen Dimensionen zuzuordnen waren (Tabelle 1).

Tabelle 1: Dimensionen der Determinanten nach Webber et al. (2010) sowie entsprechende, in LTCMo erfasste Parameter und dazugehörige Instrumente

Dimension der Determinanten	**Parameter & Messinstrument**
Kognitive Faktoren	Kognitiver Status: *Mini-Mental State Examination* (MMSE; Folstein, Folstein, & McHugh, 1975)
Psychosoziale Faktoren	Depressivität: *Geriatric Depression Scale-Residential* (GDS-12R; Sutcliffe et al., 2000); Apathie: *Apathy Evaluation Scale* (AES-D; Lueken et al., 2007; Marin, Biedrzycki, & Firinciogullari, 1991); Sturzangst: *Short Falls Efficacy Scale-International* (FES-I; Hauer et al., 2010; Yardley et al., 2005)
Umweltfaktoren	*TAFR und Transits während der Essenszeiten*, inkl. je 15 Minuten Transfer in den Essensbereich davor und danach, wurden als Maß für institutionelle Routinen getrennt von der restlichen, nicht vorgegebenen Tageszeit betrachtet.
Körperliche Faktoren	*Ambulatorischer Status* basierend auf motorischem Assessment oder Informationen des

	Pflegepersonals; Ganggeschwindigkeit: *10 meter walk test* bei maximaler Geschwindigkeit
Soziodemografische Faktoren	Alter, Geschlecht und Dauer des Pflegeheimaufenthalts
Finanzielle Faktoren	Wurden nicht erhoben

Um Multikollinearität zu vermeiden und unter Berücksichtigung der Stichprobengröße von n = 65, wurde bei Vorhandensein mehrerer signifikant korrelierter Parameter pro Dimension nur jener mit in das Modell aufgenommen, welcher den größten Beitrag zur Varianzaufklärung im Modell leistete. Um fallweise Ausschlüsse bei Fehlen einzelner Datenpunkte zu vermeiden, wurden Regressionen basierend auf „Full Information Maximum-Likelihood“ (FIML) gerechnet, d.h. unter Hinzunahme eines Datenschätzers unter der Voraussetzung des „missing at random“-Kriteriums (Schafer & Graham, 2002). Um die Assoziation der institutionell vorgegebenen Essenszeiten mit dem Life-Space während des Tages zu überprüfen, wurden TAFR und Transits während der Essenszeiten als Maß für institutionell vorgegebene Routinen getrennt von der restlichen, nicht vorgegebenen Tageszeit betrachtet. Die im vorigen Schritt errechneten Regressionsmodelle wurden nun erneut analysiert, wobei die Werte der TAFR und Transits während der Essenszeiten dann als Kontrollvariable mit aufgenommen wurden.

Ergebnisse

Der Life-Space der Pflegeheimbewohner war zum größten Teil beschränkt auf deren privates Zimmer, in dem sie durchschnittlich 36,6% der Zeit zwischen 10:00 und 18:00 Uhr verbrachten, sowie den darum befindlichen Wohnbereich (53,8%). Sie verbrachten kaum Zeit in den weiteren Bereichen des Pflegeheims (5,9%) und außerhalb des Gebäudes (3,8%). Im selben Zeitfenster wechselten sie im Mittel knapp sieben Mal die Zone (6,9 ± 3,2; Range: 0–18). Die Regressionen zeigten, dass männliches Geschlecht, niedrigere Ganggeschwindigkeit, geringere Apathie und ein besserer kognitiver Status mit häufigeren Zonenwechseln assoziiert waren (R^2 = .27; p = .002). Höhere Ganggeschwindigkeit, niedrigerer kognitiver Status und eine geringere Depressivität waren signifikant mit TAFR assoziiert (R^2 = .43; p < .001).
Die Hinzunahme der Life-Space Parameterausprägungen während der Essenszeiten als Kontrollvariablen zeigte, dass die Varianz der Life-Space Parameter während der

Essenszeiten zu einem sehr großen Teil dieselbe während des Gesamttages aufklärte (TAFR: $R^2 = .80$; $p < .001$; Transits: $R^2 = .67$; $p < .001$).

Diskussion

Diese Studie beinhaltet die erste objektive Darstellung des Life-Space von Pflegeheimbewohnern in ihrer Lebenswelt. Es zeigt sich, dass deren Lebensraum sehr begrenzt ist und deren Alltag sich zum allergrößten Teil in einem sehr engen Rahmen, innerhalb ihres Zimmers und Wohnbereichs, abspielt. Im Einklang mit dem zugrundegelegten Modell von Webber et al. (2010) wurden sowohl kognitive, psychosoziale, körperliche, soziodemografische und Umweltfaktoren als Determinanten für diesen Lebensraum identifiziert, wobei institutionellen Gegebenheiten, d.h. in diesem Fall den Essensroutinen, eine enorm hohe Bedeutung zukommt. Insbesondere das Ergebnis, dass niedrigere Ganggeschwindigkeit mit mehr Raumwechseln, höhere Ganggeschwindigkeit hingegen mit mehr TAFR verbunden ist, zeigt, dass Life-Space ein multidimensionales Konstrukt ist, welches nicht rein motorisch bestimmt ist. Dies bedeutet aber auch, dass es einer tiefergehenden Betrachtung bedarf und die hier durchgeführte Analyse als erster, oberflächlicher Einstieg in dieses Gebiet im Pflegeheimkontext betrachtet werden sollte. Neben diesen größtenteils theoretisch verwendbaren Ergebnissen gehen aus dieser Arbeit auch praktische Implikationen hervor: Da das eingesetzte Messverfahren eine räumlich-zeitliche Auflösung von Bewegungsverhalten erlaubt, könnte es zur Früherkennung geänderter Bewegungsmuster dienen, die mit demenzassoziierten Verhaltenssymptomen, anderen neurodegenerativen Erkrankungen oder einer Progression motorischer Indikationen in Verbindung stehen könnten. Im Hinblick auf den Pflegeheimalltag lässt sich aus den Ergebnissen ableiten, dass eine aktivere Gestaltung der Essensmodalitäten eine gute Möglichkeit bietet, aktives Verhalten zu fördern. Nicht zuletzt kann für Maßnahmen zur Förderung eines erweiterten Life-Space abgeleitet werden, dass eine Steigerung der Ganggeschwindigkeit sowie eine Verringerung von Apathie und Depressivität im Fokus solcher Bemühungen stehen sollten.

3.4 Manuskript IV. Pushing the Boundaries: A Physical Activity Intervention Extends Sensor-Assessed Life-Space in Nursing Home Residents

Jansen, C.-P., Diegelmann, M., Schilling, O. K., Werner, C., Schnabel, E.-L., Wahl, H.-W., & Hauer, K. (submitted). Pushing the boundaries: A physical activity intervention extends sensor-assessed life-space in nursing home residents. *The Gerontologist*.

Hintergrund

Life-Space wurde in zahlreichen Studien mit zuhause lebenden Älteren erfasst; sowohl quer- als auch längsschnittliche Daten zu Assoziationen und Determinanten sind verfügbar. Mit Life-Space assoziierte Faktoren von Pflegeheimbewohnern wurden in Manuskript III erstmals untersucht. Es besteht nach wie vor ein klarer Mangel an Studien, die eine interventionsinduzierte Modifikation des Life-Space betrachten. Basierend auf der „environmental docility hypothesis“ von Lawton and Simon (1968) und Lawton’s „environmental proactivity hypothesis“ (1989) kann davon ausgegangen werden, dass durch eine Steigerung der motorischen Kompetenz der Bewohner deren Abhängigkeit von der Umwelt verringert sowie deren Fähigkeit, umweltliche Ressourcen besser zu nutzen, gesteigert wird, was letztendlich in einer Erweiterung des persönlichen Life-Space resultieren kann. Bisher wurden zwei vergleichbare Interventionsstudien mit in eigener Häuslichkeit lebenden Älteren durchgeführt (Fairhall et al., 2012; Maki et al., 2012) und lediglich eine mit Pflegeheimbewohnern (Grönstedt et al., 2013). Allerdings kann letztere Studie nur unter großen Einschränkungen der Life-Space Forschung zugerechnet werden, da sie nicht im Hinblick auf Life-Space konzeptualisiert wurde, die Intervention in keiner Weise auf dessen Modifikation ausgerichtet war, das eingesetzte Assessment als Maß für körperliche Aktivität anstatt für Life-Space eingesetzt wurde und das Assessment-Instrument ein subjektives Fremdrating, d.h. von zweifelhafter psychometrischer Qualität, war. Diese Forschungslücke sollte durch Manuskript IV geschlossen werden, welches die Auswirkungen der LTCMo-Intervention auf den mittels objektiver, kabelloser Sensortechnik erfassten, raum-zeitlich aufgelösten Life-Space der Pflegeheimbewohner behandelt. Ein weiteres Ziel war die Überprüfung der Nachhaltigkeit der Intervention, welche nach Beendigung der Interventionsphase nach vorheriger Schulung und Vorbereitung zur eigen-

ständigen Weiterführung in die Hände der sozialen Betreuung in beiden Einrichtungen übergeben wurde.

Methoden

Die Beschreibung von Intervention, Zielgruppe, Studiendesign und Assessmentmethoden erfolgte bereits in Manuskript II und III. Aus den Rohdaten des Life-Space Assessments wurden drei verschiedene Life-Space Parameter extrahiert:

- Ein Life-Space Score (LSSc), welcher die Aufenthaltsdauer in den jeweiligen vier Life-Space Zonen zu einem selbst entwickelten Summenscore zusammenführt. Dieser kann als Maß für die „durchschnittliche“ Zone gesehen werden, in der sich ein Bewohner aufhält, wobei eine höhere Zahl einen größeren Life-Space ausdrückt.
- Die Aufenthaltsdauer außerhalb des eigenen Zimmers (TAFR), als Maß für den Aufenthalt im öffentlichen Raum.
- Die am weitesten vom Privatzimmer entfernte Zone, welche der Bewohner aufgesucht hat (MaxZ), als Maß für die insgesamt bestehende Ausdehnung des individuellen Life-Space.

In Einklang mit dem Grundgedanken des LTCMo-Projekts, all jene Bewohner in die Studie einzuschließen, die teilnehmen wollten, wurde eine statistische Methode verwendet, die eine Auswertung der Interventionseffekte über alle Messzeitpunkte unter Berücksichtigung von drop-outs und drop-ins erlaubt. Für jeden der drei betrachteten Life-Space Parameter wurde ein generalized linear mixed model (GLMM; Hedeker, 2005) modelliert, dessen Besonderheit in der Behandlung und Berücksichtigung nicht-normalverteilter Daten sowie fehlender Werte liegt (kein Ausschluss von Individuen mit fehlenden Werten) (Schafer & Graham, 2002).

Ergebnisse

Einschließlich drop-ins bestand die Stichprobe aus n = 143 Personen, wovon n = 78 am Training teilnahmen und n = 65 in der Kontrollgruppe waren. Nach Teilnahme am Interventionsprogramm zeigten sich signifikante Gruppenunterschiede in allen drei Life-Space Parametern: Bei statistischer Kontrolle von Pflegeheimzugehörigkeit, Dauer der Studienteilnahme und drop-in (ja/nein) ergab sich ein signifikant höherer LSSc ($\beta = .13$, $p = .003$), eine längere TAFR ($\beta = .28$, $p = .015$), und eine höhere MaxZ ($\beta = .29$, $p = .003$) der Interventionsgruppe im Vergleich zur Kontrollgruppe.

Zum Follow-up wurde der Effekt schwächer. Während der Effekt auf MaxZ auch zu Follow-up noch signifikant war (β = .39, *p* = .012), wurde er für LSSc noch marginal signifikant (β = .11, *p* = .065), für TAFR hingegen nicht signifikant (β = .15, *p* = .361). Es bestand zudem ein signifikanter Interaktionseffekt für MaxZ (*Pflegeheim* × *Follow-up*), welcher auf einen Unterschied der MaxZ-Verläufe beider Heime zwischen Posttest und Follow-up hindeutet (β = -.35, *p* = .038).

Diskussion

In der Studie wurde erstmals eine interventionsinduzierte Modifikation des objektiv und sensorbasiert erfassten Life-Space von Pflegeheimbewohnern untersucht und Life-Space als Hauptendpunkt sowohl in der Studienkonzeption als auch -auswertung betrachtet. Die über alle Life-Space Parameter hinweg bestehenden positiven Veränderung infolge der Intervention verblassten bis auf den Parameter MaxZ zum Follow-up. Sie deuten dennoch darauf hin, dass eine dauerhafte und eigenständige Implementierung des eingesetzten Programms möglich und, zumindest teilweise, effektiv ist. Grundsätzlich birgt eine positive Beeinflussung der Life-Space Nutzung das Potential einer Steigerung der Lebensqualität infolge häufigerer sozialer Kontakte bzw. einer Verringerung sozialer Isolation, gesteigerten Handlungsmöglichkeiten sowohl auf räumlicher als auch sozialer Ebene, und nicht zuletzt einer Verringerung alltäglicher Monotonie im Pflegeheimalltag. Eine Überprüfung solcher Auswirkungen war im Rahmen dieser Studie nicht möglich und sollte in nachfolgenden Forschungsprojekten aufgegriffen werden.

3.5 Manuskript V. Long-Term Care in Motion - A Guidebook

Jansen, C.-P., Claßen, K., Schnabel, E.-L., Diegelmann, M., Hauer, K., & Wahl, H.-W. (2015). Long-Term-Care in Motion (LTCMo) – A Guidebook. Download unter http://www.innovage.group.shef.ac.uk/assets/images/D5.1%20Guidebook_Final%20Version%202.0.pdf

Hintergrund

Der in durch die öffentliche Hand geförderten Studien immer häufiger gestellten Forderung nach Translation der wissenschaftlichen Erkenntnisse in die Praxis sollte auch in innovAge bzw. LTCMo nachgekommen werden. Vor diesem Hintergrund wurde eine ausführliche Handlungsanweisung als „Guidebook“ für Interessenten und

Interessenvertreter (Pflegeheimleitung, soziale Betreuung, therapeutisches Pflegeheimpersonal, etc.) erstellt, welches insbesondere die praktische Umsetzung des Projekts beschreibt und Empfehlungen zur nachhaltigen Implementierung der Interventionskomponenten gibt. Grundgedanke dabei ist, dass Pflegeheimpersonal, welches an der Durchführung von körperlichem Training mit Bewohnern interessiert oder damit betraut ist, unter Nutzung dieser Handlungsanweisung eigenständig zur Durchführung des LTCMo-Programms befähigt wird. Das Guidebook sollte dabei nicht nur als praktischer Leitfaden verstanden werden, sondern überdies auch relevante, theoretische Hintergrundinformationen bieten, welche die dem Projekt zugrundeliegenden Inhalte für eine nicht-wissenschaftliche Leserschaft zugänglich macht.

Methoden

Als Praxisleitfaden ist der Hauptteil des Guidebooks auf die praktische Umsetzung ausgelegt. Dies setzt eine organisatorische Vorbereitung des Settings voraus, deren wesentliche Inhalte, basierend auf den Erfahrungen aus LTCMo, im Guidebook erläutert werden. Konkrete, trainingsbezogene Maßnahmen beginnen zunächst mit der Kategorisierung der Bewohner in geeignete Trainingsgruppen, basierend auf deren ambulatorischem und motorischem Funktionsniveau und unter Berücksichtigung von verhaltensbezogenen Besonderheiten bzw. Auffälligkeiten, die insbesondere in geschützten Wohnbereichen von hoher Relevanz sind. Auf diese Weise sollen möglichst homogene Gruppen gebildet werden können, in denen Unter- bzw. Überforderung der Teilnehmer vermieden werden kann. Nachfolgend werden im Guidebook die verschiedenen Zielsetzungen, Inhalte und weiteren Charakteristika der Trainingsdurchführung und -organisation beschrieben. Gleiches gilt für die weiteren Interventionsbausteine aus LTCMo, die Einzeltrainings und das virtuelle Training (Serious Games). Die Grundlagen des Mitarbeiterkompetenztrainings werden ebenfalls ausführlich beschrieben und erläutert. Den Abschluss des Manuals bildet ein bebilderter Übungskatalog, der die wichtigsten Trainingsinhalte klar verständlich und praxisnah darbietet.
Da das im Guidebook beschriebene Interventionsprogramm bereits in Manuskript IV hinsichtlich des primären Endpunktes Life-Space evaluiert wurde, wird auf eine Ergebnisdarstellung an dieser Stelle verzichtet.

Diskussion

Durch die Kombination bewohnerzentrierter Interventionsmaßnahmen mit für Pflegeheimpersonal entwickelten Kompetenztrainings, stellt dieses Guidebook eine Besonderheit im Vergleich zu bereits vorhandenen Programmmanuals dar, welche in den meisten Fällen auf eher eindimensionale Trainingsangebote fokussiert sind. Im vorliegenden Manual werden die Trainingsinterventionen zudem auf mehreren Ebenen beschrieben und in ein feines Gruppenschema untergliedert, um dem sehr heterogenen Pflegeheimklientel möglichst gerecht zu werden. Insgesamt ist es dieser hoch-individualisierte Ansatz, der das LTCMo-Interventionsprogramm zwar sehr umfangreich, aber dafür umso wertvoller macht. Eine weitere Besonderheit ist der ausdrückliche Einschluss kognitiv stark eingeschränkter Patienten mit psychischen und Verhaltenssymptomen, die in code-gesicherten, geschützten Wohnbereichen wohnen. In einem Großteil trainingsbasierter Interventionsstudien werden derart eingeschränkte bzw. auffällige Personen ausgeschlossen, was meist mit der schwierigen Handhabbarkeit dieser Personen begründet wird, teils aber auch aus (der Meinung des Autors nach) fehlgeleiteten ethischen Aspekten geschieht. LTCMo hat gezeigt, dass ein Training mit dieser Klientel ohne Zwischenfälle machbar ist, bewohnerzentrierte Anleitung und zielgruppengerechte Organisation vorausgesetzt.
Die Machbarkeit des Programms im institutionellen Alltag wurde dadurch gezeigt, dass dieses in beiden Studien-Pflegeheimen nachhaltig implementiert wurde. Mitglieder der sozialen Betreuung wurden bereits während des Studienverlaufs in das Programm eingewiesen, sodass sie dieses nach Ende der Studie übernehmen konnten. Somit wurde auch der zu Beginn genannten Forderung nach Translation der Wissenschaft in die Praxis erfolgreich nachgekommen.

4 Einordnung der Studienergebnisse in den Forschungszusammenhang

Die wesentlichen Ergebnisse dieser Dissertation sind, dass *a)* mehrdimensionale Interventionen, welche zusätzlich zu körperlichem Training auch psychosoziale und Verhaltensaspekte berücksichtigten und Pflegeheimpersonal miteinbeziehen, die vielversprechendsten Effekte auf körperliche Aktivität zeigen (Manuskript I); *b)* Bewohner der stationären Altenpflege einen sehr eingeschränkten Life-Space haben, der stark von institutionellen Gegebenheiten mitbestimmt wird (Manuskript III); c*)* Bewohner hinsichtlich ihres Life-Space und dessen alltäglicher Nutzung von einer mehrdimensionalen, individualisierten Intervention mit Schwerpunkt auf körperlichem Training profitieren können (Manuskript IV); *d)* die nachhaltige Implementierung des Interventionsansatzes in den Institutionen erfolgreich war, wobei die im Anschluss an die Intervention gezeigten, signifikanten positiven Effekte auf den Life-Space der Bewohner zum Follow-up teilweise bestehen blieben (Manuskript IV).

Wie aus Manuskript I hervorgeht gibt es bisher nur sehr wenige Studien, welche Effekte von Interventionen auf die körperliche Aktivität von Bewohnern der stationären Altenpflege überprüft haben. Noch weniger Studien haben dabei körperliche Aktivität überhaupt als dezidierten Endpunkt betrachtet. Bezogen auf Life-Space ist die Datenlage noch ernüchternder: Lediglich eine Interventionsstudie mit Pflegeheimbewohnern hat bisher überhaupt Life-Space erfasst (Grönstedt et al., 2013), wobei diese Studie nicht im Hinblick auf Life-Space konzeptualisiert wurde, die Intervention in keiner Weise auf dessen Modifikation ausgerichtet war, das eingesetzte Assessment (NHLSD; vgl. Kap. 1.3.3 und 1.6.2) als Maß für körperliche Aktivität anstatt für Life-Space eingesetzt wurde und das Assessment-Instrument ein subjektives Fremdrating war. In LTCMo war es durch den Einsatz einer sensorbasierten Messmethode daher erstmals möglich, den Life-Space von Pflegeheimbewohnern objektiv und mit einer hohen räumlichen und zeitlichen Auflösung deskriptiv darzustellen, dessen Determinanten in der institutionellen Umwelt aufzuzeigen (in Manuskript III) sowie interventionsinduzierte Veränderungen zu beobachten und zu evaluieren (in Manuskript IV). Derartige Daten waren bis dahin nur bei zu Hause lebenden Älteren erhoben worden (vgl. Kap. 1.6.2), die jedoch im Hinblick auf ihre physische und soziale Umwelt, körperliche und kognitive Funktion, medizinische Indikationen sowie psychosoziale Eigenschaften kaum vergleichbar mit Pflege-

heimbewohnern sind. Zwar zeigte die querschnittliche Analyse der LTCMo-Daten, dass die übergeordneten Kategorien der von Webber et al. (2012) nachgewiesenen Life-Space Determinanten von zu Hause lebenden Älteren auch im institutionellen Setting Gültigkeit besitzen. Jedoch werden diese in hohem Maße durch institutionelle Routinen „überschattet“, welche eine vielfach höhere Varianzaufklärung des Life-Space zeigten, als alle anderen Faktoren (vgl. Manuskript III).

Die gefundenen positiven Interventionseffekte stehen im Einklang mit den zur Hypothesenbildung herangezogenen Modellen von Lawton zur „Environmental Docility“ und „Environmental Proactivity“, welche nahelegen, dass Pflegeheim-bewohner durch eine gesteigerte motorische und/oder psychosoziale „Kompetenz“ einerseits ihre Abhängigkeit von ihrer institutionellen Umwelt verringern und andererseits die Nutzung darin vorhandener Ressourcen steigern können. Ein solcher Effekt wurde bisher nur in einer weiteren Studie mit in eigener Häuslichkeit lebenden Älteren bestätigt, allerdings bei einer nach Frailty-Kriterien ausgerichteten, multidisziplinären Intervention sowie unter Einsatz einer auf Selbstauskunft basierenden Messmethode (Fairhall et al., 2008; 2012).

Kognitive Einschränkungen, oftmals verursacht durch demenzielle Erkrankung und nicht selten verbunden mit zum Teil schwerwiegenden Verhaltensauffälligkeiten, werden häufig als Ausschlusskriterium für eine Studienteilnahme angeführt (Taylor, DeMers, Vig, & Borson, 2012). Dies bestätigte sich auch in dem durchgeführten systematischen Review (Manuskript I). Ein solches exklusives Vorgehen widerspricht gänzlich dem Alltag in der stationären Altenpflege, der einen täglichen Umgang mit allen Bewohnern erfordert, ungeachtet deren Erkrankungen und Verhaltensauffälligkeiten. Folglich war es eine Grundvoraussetzung für das LTCMo-Projekt, ein Interventionsprogramm für Pflegeheimbewohner zu entwickeln, welches möglichst allen Bewohnern zugänglich gemacht werden sollte. Dies beinhaltete sogar jene, welche erst später in das Pflegeheim einzogen, aber dennoch in die bereits laufende Studie einsteigen konnten. Die Ergebnisse zeigen, dass dieser Ansatz im Hinblick auf die Interventionskonzeption erfolgreich war: Sowohl das Gruppentraining als auch Einzeltraining konnte auf allen Wohnbereichen, inklusive der code-gesicherten Wohnbereiche für verhaltensauffällige Bewohner, durchgeführt werden, ungeachtet teils schwerster kognitiver und motorischer Schädigung. Die Trainingsadhärenz war dabei hoch, mit nur sehr wenigen Studienabbrüchen, die mit einer kognitiven Schädigung begründet waren. Es zeigte sich allerdings auch, dass die Datener-

hebung bei kognitiv stark eingeschränkten Teilnehmern mit großen Problemen verbunden ist, die zu zahlreichen fehlenden Daten durch Nichteinhaltung des Messprotokolls oder Ablehnung der Teilnahme an Messungen bzw. Befragungen führte. Hinzu kommt ein erwartungsgemäß hoher Anteil an krankheitsbedingten Ausfällen und, über die lange Zeitspanne hinweg, auch Todesfällen.

Um dieser methodischen Problemstellung und der darin begründeten hohen Datenkomplexität auf datenanalytischer Ebene gerecht zu werden, wurden die Interventionseffekte mittels GLMMs überprüft. Dieser längsschnittliche Auswertungsansatz erleichtert den Umgang mit nicht-normalverteilten Daten und erlaubt einen zeitgemäßen Umgang mit fehlenden Werten. Anstatt im Sinne listenweiser Ausschlüsse die Stichprobe zu verkleinern, berücksichtigen GLMMs alle vorhanden Daten der Teilnehmer zu jedem Messzeitpunkt, inklusive Daten später eingestiegener „drop-ins“. Dieser Auswertungsansatz bietet enormes Potenzial und könnte sich als Standard etablieren, insbesondere in Studien mit „speziellen“ Stichproben, bei denen eine unvollständige Datenstruktur erwartbar ist.

Ein weiteres, sehr wesentliches Ziel des Projekts war die nachhaltige Implementierung der Interventionskomponenten in den Institutionen. Dabei sollte das Programm auch das Potenzial haben, in externen Einrichtungen übernommen und eigenständig durchgeführt zu werden. Diesem Gedanken folgend, wurde in beiden Studienpflegeheimen unmittelbar im Anschluss an den Interventionszeitraum das körperliche Trainingsprogramm eigenständig durch Mitarbeiter der sozialen Betreuung übernommen. Zuvor hatten diese bereits in der laufenden Intervention Einblicke erhalten, wurden nach und nach stärker integriert und erhielten Schulungen zur Intervention. Der Autor war zu Beginn und im weiteren Verlauf zur Unterstützung der Durchführung und nachhaltigen Implementierung regelmäßig anwesend; das Guidebook (Manuskript V) wurde zu diesem Zweck erstellt und öffentich zugänglich gemacht. Die Ergebnisse zeigten, dass der signifikante positive Effekt bei einem der drei erfassten Life-Space Parameter (MaxZ) bestehen blieb. Dies verdeutlicht das Potenzial des Programms, auch im nicht-wissenschaftlichen Kontext von Nutzen zu sein für eine Erweiterung des Life-Space von Pflegeheimbewohnern.

5 Fazit und Ausblick

Mit dieser Arbeit wurden erstmals der Life-Space und dessen Determinanten von Bewohnern der stationären Altenpflege beschrieben. Der starke Einfluss institutioneller Routinen auf den Life-Space zeigt, dass die Institutionen selbst einen sehr wesentlichen Ansatzpunkt darstellen, ohne dessen Berücksichtigung Interventionen im Pflegeheim ins Leere zu laufen drohen. Die Idee, das „ganze Heim“, also Leitungsebene, Pflege und soziale Betreuung, mit einzubeziehen und „in Bewegung“ zu versetzen, sollte hier Leitgedanke sein. Dies ist sowohl für eine „top-down“ regulierte Implementierung von Studieninterventionen sinnvoll, als auch für die nachhaltige und autonome Weiterführung der Programme seitens der Institutionen selbst. Jene profitieren vor allem dadurch, dass oftmals vorhandene, unstrukturierte Aktivitäten wie bspw. Sitzgymnastik durch strukturierte, evidenzbasierte als auch effektivere Programme ersetzt werden können, welche sowohl den Bewohnern und dem Personal zugutekommen: Dadurch gesteigerte motorische Funktionen und psychosoziale Ressourcen können die Lebensqualität und Autonomie der Bewohner fördern, die Arbeitsbelastung des Pflegepersonals durch einen geringeren Pflegeaufwand verringern und das „Klima“ in der Einrichtung positiv beeinflussen. Die in LTCMo durchgeführte mehrdimensionale Intervention stellt ein solches Programm dar, erste Evidenz zum positiven Effekt des Programms auf Life-Space Parameter wurde im Rahmen dieser Arbeit erbracht. Es zeigte sich, dass Bewohner durch eine Teilnahme am Programm zu einer umfangreicheren Nutzung ihres Life-Space stimuliert und gewissermaßen befähigt werden konnten. Zwar wurde der Zusammenhang des Life-Space mit relevanten Parametern wie gesteigerter Lebensqualität, erhöhter sozialer Teilhabe und verringerter Einsamkeit im Rahmen dieser Arbeit nicht untersucht. Dennoch sprechen die gefundenen Ergebnisse, dass die Bewohner ihren Life-Space erweiterten und weniger Zeit in ihren Privatzimmern bzw. mehr Zeit in öffentlichen Bereichen der Einrichtungen verbrachten, für ein größeres Potenzial an bedeutungsvoller und reicherer Teilhabe am öffentlichen Alltag in den Institutionen. Eine Untersuchung dieser Fragestellung im Rahmen zukünftiger Projekte scheint in Anbetracht der Studienergebnisse naheliegend und sinnvoll. Darüberhinaus ist die Ausprägung und Nutzung des Life-Space aufgrund seiner Assoziation mit klinisch relevanten Faktoren wie motorischer und kognitiver Funktion, Depressivität und Apathie gegebenenfalls geeignet, Verschlechterungen

dieser Faktoren sowie Verhaltensänderungen frühzeitig zu erkennen. Ebenso könnte es in Ergänzung zu neuropsychiatrischen Screeningverfahren dazu dienen, Verhaltensauffälligkeiten wie agitiertes Verhalten (bspw. zielloses Umherirren) oder Apathie zu identifizieren. Der wichtige Schritt, die Umsetzung des Programms in die nicht-wissenschaftliche Praxis zu ermöglichen, wurde durch das offen zugängliche Guidebook gemacht. Bemühungen, das Programm flächendeckend bekannt zu machen, sind zum Zeitpunkt der Fertigstellung dieser Arbeit noch nicht abgeschlossen.

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Abkürzungsverzeichnis

ADL	Activities of Daily Living
AES-D	Apathy Evaluation Scale
BADL	Basic Activities of Daily Living
CONSORT	Consolidated Standards of Reporting Trials
FES-I	Falls Efficacy Scale-International
FIML	Full Information Maximum-Likelihood
GDS-12R	12-item Geriatric Depression Scale-Residential
GLMM	Generalized Linear Mixed Model
GPS	Global Positioning System
LSA	University of Alabama at Birmingham Life-Space Assessment
LSD	Life-Space Diary
LSH	Life-Space Mobility at Home
LSQ	Life-Space Questionnaire
LSSc	Life-Space Parameter: Life-Space Score
LTCMo	Long-Term Care in Motion
MaxZ	Life-Space Parameter: maximale Zone, die aufgesucht wurde
MMSE	Mini-Mental State Examination
NHLSD	Nursing Home Life-Space Diameter
RCT	Randomized Controlled Trial
RFID	Radio-Frequency Identification
SGB	Sozialgesetzbuch
TAFR	Life-Space Parameter: verbrachte Zeit außerhalb des privaten Zimmers
Transits	Life-Space Parameter: Häufigkeit der Zonenwechsel

Weitere dissertationsverbundene Publikationen und Kongressbeiträge des Autors

Nachfolgende Publikationen wurden in Erst- oder Co-Autorenschaft des Verfassers dieser Dissertation erstellt. Sie stehen in Verbindung mit dem LTCMo-Projekt, wurden jedoch aufgrund ihrer Abweichung von der thematischen Ausrichtung der Dissertation nicht in diese integriert.

Weiter unten aufgeführte, wissenschaftliche Vorträge bzw. Kongressbeiträge dienten dem wissenschaftlichen Diskurs mit Fachkollegen im Rahmen nationaler und internationaler Fachtagungen. Ebenso sollte das Projekt auf diese Weise international bekannt gemacht werden um, neben der nicht-wissenschaftlichen Dissemination durch das Guidebook, die wissenschaftiche „Reichweite“ der Projektinhalte zu vergrößern. Hinzu kommen Vorträge im Rahmen von innovAge „Stakeholder Meetings“, welche eine Darstellung und Diskussion der Projektinhalte und -maßnahmen mit Interessensvertretern aus Wirtschaft, Gesundheitssektor und Altenpflege zum Ziel hatten.

Publikationen (Englisch)

Diegelmann, M., **Jansen, C.-P.**, Wahl, H.-W., Schilling, O. K., Schnabel, E.-L., & Hauer, K. (2017). Does a Multi-Component Physical Activity Intervention in the Nursing Home Impact on Depressive Symptoms? A Generalized Linear Mixed Model Approach. *Aging and Mental Health. DOI: 10.1080/13607863.2017.1310804*

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Jansen, C.-P., Köpp, P. & Hauer, K. (2014). Effekte körperlichen Trainings auf psychische und Verhaltenssymptome bei Demenz. In Baden-Württemberg Stiftung gGmbH (Hrsg.). Therapie bei Demenz – Körperliches Training bei

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Wissenschaftliche Vorträge und Posterbeiträge

Jansen, C.-P., Bauer, J. M., Wahl, H.-W., & Hauer, K. (2016, Oktober). *Falls, risk exposure, and autonomy in high risk populations: contradicting goals or comprehensive strategy?* Colloque Scientifique - Franco-German Symposium, Montpellier, Frankreich.

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Diegelmann, M., **Jansen, C.-P.**, Schnabel, E., Wahl, H.-W., Schilling, O., & Hauer, K. (2016, September). *Körperliches Training und Depressivität bei Pflegeheimbewohnern.* 14. Kongress der Deutschen Gesellschaft für Gerontologie und Geriatrie (DGGG), Stuttgart, Deutschland. Zeitschrift für Gerontologie und Geriatrie, Band 49, Supplement 1, S13.

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Erklärung gemäß § 8 Abs. (1) c) und d) der Promotionsordnung der Fakultät für Verhaltens- und Empirische Kulturwissenschaften

Promotionsausschuss der Fakultät für Verhaltens- und Empirische Kulturwissenschaften der Ruprecht-Karls-Universität Heidelberg

Erklärung gemäß § 8 (1) c) der Promotionsordnung der Universität Heidelberg für die Fakultät für Verhaltens- und Empirische Kulturwissenschaften

Ich erkläre, dass ich die vorgelegte Dissertation selbstständig angefertigt, nur die angegebenen Hilfsmittel benutzt und die Zitate gekennzeichnet habe.

Erklärung gemäß § 8 (1) d) der Promotionsordnung der Universität Heidelberg für die Fakultät für Verhaltens- und Empirische Kulturwissenschaften

Ich erkläre, dass ich die vorgelegte Dissertation in dieser oder einer anderen Form nicht anderweitig als Prüfungsarbeit verwendet oder einer anderen Fakultät als Dissertation vorgelegt habe.

Vorname Nachname _____

Datum, Unterschrift _____

Anhang: Manuskripte zur publikationsbasierten Dissertation

Manuskript I

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Effects of interventions on physical activity in nursing home residents

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Abstract

The aim of this review was to evaluate current evidence regarding the effects of interventions on physical activity in the subgroup of nursing home residents as well as to critically review the assessment methods used in this regard. Published studies through January 2015 were searched in The Cochrane Library, PubMed, CINAHL, Web of Knowledge, PsycInfo, Psyndex, Psycarticles, CC Med, and DissOnline; and by manual search. For Randomized Controlled Trials (RCTs) to be included an intervention had to be conducted with nursing home residents aged 65 years and older and physical activity had to be assessed using standardised, quantitative methods. Study quality was evaluated using an established Cochrane rating tool for RCTs. Eight studies met the inclusion criteria. Only one intervention study with main focus on a modification of physical activity-behavior could be identified. Physical activity assessments used in the studies were partly limited regarding objectivity or psychometric quality. Hence, the documentation of effects of interventions is restricted. Six studies reported significant increases of physical activity in nursing home residents and thus positive intervention effects, which points at the feasibility and high potential of intervention programs to promote physical activity in this setting. Enhanced individual contact as well as physical exercise combined with behavioral interventions and the inclusion of nursing staff seems to be most effective in this regard. As only one study involved post-intervention follow-up assessments, sustainability of effects remained unclear.

Key words: nursing home residents, physical activation, intervention, older people

Introduction

In most countries, the percentage of older people receiving long-term institutional care has remained stable despite demographic change towards an ageing population (Rodrigues et al. 2012). One main reason for this is that current policy measures emphasize the strengthening of home care rather than of institutional care (Rodrigues et al. 2012). Even though home care is the predominant care setting in Europe (Rodrigues et al. 2012), the number of dependent older persons living in care institutions such as nursing homes (NH) will remain high in Europe (European Commission [Directorate-General for Economic and Financial Affairs and Economic Policy Committee (Ageing Working Group)] 2009). Hence, measures to raise healthy life years should focus on institutionalised older people as well.

One major means to promote health in institutionalized and non-institutionalized older people is to maintain or even increase physical activity (PA) (Crocker et al. 2013; Foster et al. 2005). Positive effects of PA interventions on physical and cognitive function have been reported in the general older population as well as older people with dementia, some of which were residing in long-term care institutions (Potter et al. 2011). It can be expected that PA interventions may also lead to improvements in disability status in the group of NH residents. However, studies show that without regular motivation or prompts fostering PA, most NH residents stay inactive (Scherder et al. 2010). Respective studies demonstrate that compared to non-institutionalized seniors, NH residents are considerably less active (Bates-Jensen et al. 2004; MacRae et al. 1996) and far from meeting the widely acknowledged guidelines issued by the World Health Organization (WHO). The guidelines recommend at least 150 minutes of moderate-intensity PA per week—i.e., 30 minutes a day, five days a week for older adults aged 65 and above (WHO 2010). It is questionable whether these general guidelines apply for multi-morbid, frail nursing home residents. Until now more specific recommendations taking into account the characteristics of this specific population do not exist. NH residents show pronounced individual restrictions and deficits (e.g., sensory losses, depression, dementia-related disorders, motor impairment, multi-morbidity) (Phillips et al. 2004; Slaughter et al. 2011), they face restrictive environmental factors (e.g., limited outdoor accessibility) and have specific attitudes and experiences (e.g. attitude towards aging or PA); all these conditions making it difficult to meet such general

recommendations (van der Bij et al. 2002). Moreover, although steps have been undertaken to refrain from custodial measures like physical restraints (e.g., the "Expert Standard for Fall and Fracture Prevention"; German Network for Quality Development in Care 2006), they are still common practice in nursing facilities. Aiming to prevent falls or other adverse events (de Vries et al. 2004), they also lead to an aggravation of immobility and inactivity. At the psychological level, many NH residents experience difficulties in living a self-determined, active, and stimulating life (Riedl et al. 2012). In particular, their sedentary lifestyle and thus the absence of PA participation may weaken self-efficacy (McAuley and Blissmer 2000), resulting in even more passive behaviour, which may lead to a vicious circle overall.

Reviewing the existing body of research on PA and old age, many studies addressing PA in older adults focused on community-dwelling older adults (van der Bij et al. 2002) or older people with dementia (Potter et al. 2011). Some studies even have purposefully excluded NH residents (Foster et al. 2005). Considering the examined outcomes, reviews on interventions with NH residents focused on deficits in (Instrumental) Activities of Daily Living [ADL/IADL] (Crocker et al. 2013) or functional performance (Rydwik et al. 2004). We are not aware of any review targeting PA changes as outcome of PA interventions in the NH setting.

In NH residents, there are some specific challenges with regard to the accurate measurement of PA. Due to impaired cognitive status and complex constellations of multi-morbidity, in most residents accuracy of recall and self-report are limited (Hauer et al. 2011). Subjective assessments such as questionnaires and interviews partially involve subjective judgement, which may lead to imprecision and limited reliability (Allet et al. 2010; de Bruin et al. 2008). Objective technical assessments often have the problem that activity clusters in frail older persons are usually characterized by short activity episodes that are somewhat complicated to identify. Due to these challenges and difficulties regarding PA assessment and the bias in the results this may lead to, an evaluation of the quality of the PA measurements used in the studies will be included in the analysis of the identified studies.

Study Objectives

Given the beneficial effects of PA on a range of physical as well as psychological outcomes in older people, the identification of effective interventions to

enhance PA is of high relevancy. This applies especially to the population of NH residents as they show a pronounced sedentary lifestyle. Therefore, the aim of this review is to investigate existing evidence regarding the effects of interventions on PA in NH residents and to critically review the assessment methods used to measure PA.

Methods

The literature search comprised the following bibliographic databases from the starting year of each database's index through January 2015: The Cochrane Central Register of Controlled Trials (The Cochrane Library 2015, Issue 1), PubMed, CINAHL, PsycInfo, Psycarticles, Psyndex, Web of Knowledge, Current Contents Medizin (CC Med), and DissOnline. Due to the language capacity of the authors, the search was limited to English and German titles, abstracts, and vocabulary thesauruses (e.g., "MeSH" or CINAHL Headings Thesaurus). In order to detect a maximum number of relevant studies, an extensive search was conducted and adjusted to each electronic database. In addition, reference lists of related articles were manually scanned and experts in the field were contacted. As an example, the search conducted in PubMed is presented in Table 1. The inclusion criteria were (1) study type: RCTs; (2) outcome: PA; (3) setting: NH (4) study population: NH residents aged 65 and older. Identified articles were processed in a reference management program (see Figure 1). After removing duplicate papers, the remaining studies were assessed by title and corresponding abstracts. Papers out of scope were excluded. The remaining potentially relevant studies were assessed for eligibility by screening their abstracts—and in case of ambiguity—the full paper. Papers presumably meeting the inclusion criteria were retrieved, examined in detail, and included in the review if the inclusion criteria were fully met. Additionally, quality of studies was evaluated using a standardized rating tool. Each step of study selection, data extraction, and quality rating was performed independently by two review authors (CPJ and KC). Any disagreements were resolved by consensus or third-party adjudication (KH and HWW).

Table 1: Overview of Search Terms Used in PubMed

LTC Setting	**Physical Activity**
#1 “nursing home”[tiab]	#18 "Sedentary Lifestyle"[Mesh:NoExp]
#2 “nursing homes”[tiab]	#19 "Human Activities"[Mesh:NoExp]
#3 Institutionali*[tiab]	#20 "Movement"[Mesh:NoExp]
#4 “long-term care”[tiab]	#21 "Locomotion"[Mesh:NoExp]
#5 “residential home”[tiab]	#22 "Motor Activity"[Mesh:NoExp]
#6 “rest home”[tiab]	#23 “active living” [tiab]
#7 “special-care home”[tiab]	#24 “active lifestyle” [tiab]
#8 “home for the elderly”[tiab]	#25 “activity exercise” [tiab]
#9 Pflegeheim[tt]	#26 “activity promotion”[tiab]
#10 Altersheim[tt]	#27 aktivier*[tt]
#11 Seniorenheim[tt]	#28 aktivit*[tt]
#12 Altenheim[tt]	#29 activat*[tiab]
#13 "Nursing Homes"[Mesh]	#30 “spontaneous activity”[tiab]
#14 "Institutionalization"[Mesh]	#31 “spontaneous activities”[tiab]
#15 "Long-Term Care"[Mesh]	#32 “activity level”[tiab]
#16 "Homes for the Aged"[Mesh]	#33 “sedentary lifestyle”[tiab]
#17 OR (#1-#16)	#34 “motor activity”[tiab]
	#35 “motor activities”[tiab]
	#36 “human activity”[tiab]
	#37 “human activities”[tiab]
	#38 movement[tiab]
	#39 locomotion[tiab]
	#40 “daily activity”[tiab]
	#41 “activity habits”[tiab]
	#42 “habitual activity”[tiab]
	#43 “habitual activities”[tiab]
	#44 “physical activity“[tiab]
	#45 “physical activities“[tiab]
	#46 OR (#18-#45)
Combination of the synonyms:	#47 (#17 AND #46)
	#48 #47

Study-quality Rating

Each original RCT was evaluated based on a rating system for RCTs developed by the Cochrane Bone, Joint and Muscle Trauma Group (for more detailed description see Latham et al. 2003). Scoring range lies within 0 and 16 (highest quality) points. For each of the eight criteria, a score of two, one, or zero

points could be obtained. Two points were given if provided information fully met the criterion; one point was given if the criterion was not fully met (e.g., due to situations such as a small but possible chance of disclosure of assignment; unblinding of some of the assessors; small confounding of treatment and control group; inadequate definitions). Zero points were given if the criterion was not met (e.g., non-randomized trial; inadequate detail that did not allow the reviewer to check or carry out an intention-to-treat analysis; no attempt to blind assessors to the assignment of treatment; statistically significant differences between the groups without adjustment made in the analysis or the lack of description of the treatment groups at baseline) or if there was insufficient or unclear information provided.

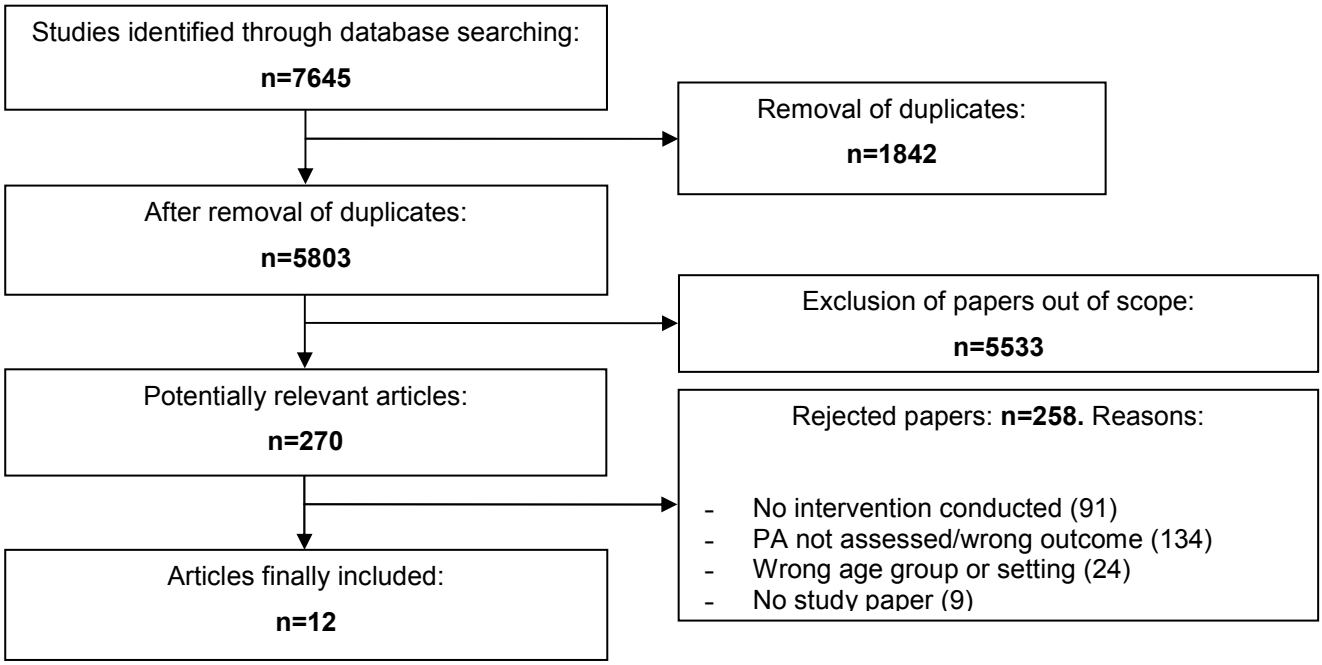
Data extraction

In accordance with the study objectives, the following data were extracted from the studies: the type of interventions conducted as well as the effects of those interventions on PA; the outcome measurements used as well as their psychometric quality; important characteristics of the study populations. In addition, effect sizes were calculated if required information was presented in the paper.

Results

Eight studies fully met the inclusion criteria and were included in final data extraction (see Figure 1). Descriptive data of included studies regarding study design, interventions, outcome measurements, type and effects of interventions are presented in Table 2 (at the end of the manuscript).

Figure 1: Flowchart of Literature Search and Study Selection



Study Quality

Table 3 (at the end of the manuscript) shows the results of the study quality rating tool. We acknowledge that some of the rated studies may have been underrated due to a possible lack of presentation of methodological issues. The eight RCTs were evaluated by the rating tool described above and had an average rating score of 10.8 (range 8-15).

The highest-rated study (Galik et al. 2014) fulfilled 83% and the lowest-rated study (Lobo et al. 2010) fulfilled 50% of the rating criteria. Several studies shared methodological weaknesses or did not provide the required information to allow rating of intention-to-treat analysis (Chin A Paw et al. 2006; Lobo et al. 2010; Schnelle et al. 2010; Simmons and Schnelle 2004), outcome-assessor blinding (Fiatarone et al. 1994; Lobo 2010; Schnelle et al. 2010), and treatment concealment (Lobo et al. 2010). Moreover, only Galik et al. (2014) provided sufficient information about whether the care programs—other than the trial options—were identical across participating NHs. Lobo et al. (2010) stated that their trial was not a true RCT due to recruitment implications in the different institutions. However, as the eight participating NHs in this study were randomly selected, this study was nevertheless included in the review.

Study Design and Major Study Characteristics

Studies were published between 1995 (Schnelle et al.) and 2014 (Grönstedt et al.); five of the studies came from the U.S., three from Europe (Table 2). Mean sample size was 129 participants, ranging from N=76 to N=266. Mean age of participants across studies varied between 75 and 89 years. Inclusion criteria differed between studies. Several studies excluded residents with walking limitations or other physical limitations (Chin A Paw et al. 2006; Fiatarone et al. 1994; Lobo et al. 2010; Schnelle et al. 1995); Lobo et al. (2010) excluded cognitively impaired persons; however, most of the studies included cognitively impaired subjects or mentioned cognitive impairment as inclusion criteria (Galik et al. 2014). Most participants were described as being at risk of functional and cognitive decline. Cognitive status was assessed in seven studies by the Mini-Mental State Examination (see MMSE scores in Table 2) and had a mean range from 8.7 to ≥ 24. Following the MMSE cut-off ranges as classified by Eschweiler et al. (2010), two studies reported severe dementia (Galik et al. 2014; Schnelle et al. 2010; 0-10 points), three studies reported

moderate dementia (Grönstedt et al., 2005; Schnelle et al. 1995; Simmons and Schnelle 2004; 10-19 points), and one study reported mild dementia (Fiatarone et al. 1994; 20-26 points).

Study duration varied between eight weeks and 15 months, in which baseline and final assessments were performed (Table 2). One study (Lobo et al., 2012) conducted post-intervention follow-up assessments three months after the intervention.

In-depth Analysis of Intervention Programs

Although seven studies shared that exercise interventions were implemented, interventions were very heterogeneous (Table 2). They consisted of resistance training (Chin A Paw et al. 2006; Fiatarone et al. 1994; Lobo et al. 2010; Simmons and Schnelle 2004), aerobic training /walking (Lobo et al. 2010), functional-skills training (Chin A Paw et al. 2006), repeated sit-to-stands and walking (Schnelle et al. 2010), functional incidental training (Schnelle et al. 1995), function-focused care (FFC) for nursing staff (Galik et al. 2014) and individually tailored activities (Grönstedt et al. 2005). Four studies used behavioral interventions that included prompted voiding (Schnelle et al. 1995), scheduled toileting (Schnelle et al. 2010; Simmons and Schnelle 2004), encouragement to be more active (Simmons and Schnelle 2004), and a health education program (Lobo et al. 2010). Additionally, two studies involved other interventions, such as nutritional supplement (Fiatarone et al. 1994) and a periodical offering of snacks and fluids (Schnelle et al. 2010). Five studies used multi–component-type interventions, i.e., a multiple-exercise program (Chin A Paw et al. 2006); a combination of behavioral programs and exercise (Schnelle et al. 2010; Simmons and Schnelle 2004); programs combining exercise and nutritional-supplement strategies (Fiatarone et al. 1994), and exercise and prompted voiding (Schnelle et al. 1995). In one study, a staff-based intervention with the intention to change the philosophy of nursing care towards PA optimization in residents was implemented (Galik et al. 2014).

The exercise programs were performed for 30-60 minutes per session, varying from one to seven days per week (calculated mean=4.4). Training periods varied between eight weeks and 1 year. In three studies, short (five minutes) bouts of interventions were conducted up to four times a day (Schnelle et al. 1995, 2010; Simmons and Schnelle 2004). Adherence rates varied from 60% (Lobo et al. 2010) to 97% (Fiatarone et al. 1994); one study gave no information on adherence

(Simmons and Schnelle 2004). Control-group activities consisted in all instances of the continuation of usual care and other activities (see Table 2).

Effects of Interventions

The main findings regarding effects of interventions on PA are displayed in Table 2. Six of eight studies reported significant between-group-differences in PA of intervention groups compared to control groups (Fiatarone et al. 1994; Galik et al. 2014; Grönstedt et al. 2012; Lobo et al. 2010; Schnelle et al. 2010; Simmons and Schnelle 2004). For two of these studies (Lobo et al. 2010; Simmons and Schnelle 2004) effect sizes were calculated as shown in Table 2 (according to Klauer 2001), with both showing large effects ($d > 0.8$; see Cohen 1988). Two studies did not report significant between-groups differences in PA (Chin A Paw et al. 2006; Schnelle et al. 1995). In the study by Schnelle et al. (1995), a significant increase of PA in the intervention as well as the control group was reported.

Except for Galik et al. (2014), all of the studies included some sort of exercise component in their intervention that led to significant differences in PA between groups in five of seven cases. These consisted of resistance/strength training, aerobic training or functional exercises. In both studies that applied a combination of exercise and behavioral interventions, significant increases of PA were achieved. In these, scheduled toileting (with assistance) and encouragement to drink were implemented in addition to exercises. Effects of interventions on PA seemed not to be dependent on study quality. Drop-out rates were variable, ranging from 6% (Fiatarone et al. 1994) to 30% (Chin A Paw et al. 2006).

Outcome Measurements

In four of the studies, PA was explicitly indicated as a primary outcome (Fiatarone et al. 1994; Galik et al. 2014) or secondary outcome (China A Paw et al. 2006; Grönstedt et al. 2012). The remaining four studies did not provide information in that respect. PA was assessed using objective technical devices, questionnaires or surveys (Table 3 and 4) or both. One study did not use objective technical assessment methods at all (Grönstedt et al. 2004). Objective technical assessment was performed using motion sensors such as the Actigraph, the Caltrac Motion Sensor, or the GMM activity monitor (Table 3). One study did not provide information about type and model of the movement device used (Schnelle et al., 2010). Motion sensors recorded either movement counts per time, estimated energy expenditure,

or time spent in activities. None of the devices provided a more detailed quantitative analysis including parameters such as time/frequency of activities as classified by walking, standing, lying, sitting, transitions or even qualitative gait analysis as provided in recent high-technical assessments. PA assessment devices were worn during daytime for at least eight hours on two days. Only Fiatarone et al. (1994) had daytime and nighttime data after recording activity for 72-hour periods. The devices were worn on hip, thigh, or ankle. None of the studies provided a life space assessment documenting location and area of activities.

The only questionnaire used was the LASA Physical Activity Questionnaire (LAPAQ; Chin A Paw et al. 2006). Observations consisted of one-minute, time-sampled observations (Schnelle et al. 1995; Simmons and Schnelle 2004), the Physical Activity Survey for Long-Term Care (PAS-LTC; Galik et al. 2014), the Nursing Home Life Space Diameter (NHLSD; Grönstedt et al. 2012) and one observation not described in detail (Schnelle et al. 2010). Overall, validity and reliability were scarcely addressed (see Table 4 and 5). In two studies information was provided, four studies at least stated where information on validity and reliability is provided.

Table 4: Methods of PA Assessment as Reported in Identified Studies: Objective Technical Assessment

Device	Author	Unit	Reliability	Validity
Actigraph	Chin A. Paw et al.	Counts	-	-
	Galik et al.		test-retest: r=0.98	r=0.35*(sedentary activity) r=0.46*(physical activities) r=0.71*(heart rate) r=0.73*(oxygen uptake)
	Lobo et al.		-	source mentioned
Caltrac	Schnelle et al., 1995	kcal/h	-	-
	Simmons and Schnelle		-	-
GMM activity monitor	Fiatarone et al.	Counts	-	-
Not specified	Schnelle et al., 2010	-	r=0.67[+]	previous work

[+] = Pearson correlation between two observers; * = significant correlation

Table 5: Methods of PA Assessment as Reported in Identified Studies: Observation/Questionnaire

Method	Study	Specification	Reliability	Validity	Standardization
Observation	Galik et al.	PAS-LTC	r=0.82-0.94*	r=0.55-0.60^{+}	yes
	Grönstedt et al.	NHLSD	source mentioned	source mentioned	yes
	Simmons and Schnelle	1-min., time-sampled observations	-	-	yes
	Schnelle et al., 1995		-	-	yes
Questionnaire / Survey	Chin A. Paw et al.	LAPAQ	-	source mentioned	yes

Note. - = no information provided in the paper; NHLSD=Nursing Home Life-space Diameter; LAPAQ=LASA Physical Activity Questionnaire; * = inter-observer/inter-rater reliability as mentioned in the paper; $^{+}$ = criterion-referenced validity based on bivariate correlations (with Actigraph)

Discussion

We used a broad literature search strategy that identified only a limited number of adequate studies to report on effects of interventions on PA in NH populations. This indicates a lack of research in this field.

We found positive effects of interventions on PA in NH residents. Most of the included studies support or at least partially support this finding. Effect sizes calculated for two studies showed large effects, statistically supporting this finding.

All studies were analysed and evaluated with our main focus on PA, although it has to be pointed out that most studies were not designed to promote and assess PA as a primary outcome. However, with PA as a secondary study focus, the significant increases in PA emphasize the potential and feasibility of interventions for this highly vulnerable population of NH residents. Consequently, effects might be substantially increased in future studies with primary focus on PA promotion.

On average most of the study samples were cognitively impaired according to a MMSE score. With the exception of one, all of the studies that included cognitively impaired subjects found positive effects of interventions on PA. However, no study distinguished between cognitively impaired and non-impaired subjects – hence, no conclusions on the association between cognitive impairment and intervention effects can be drawn.

Regarding the kind of interventions undertaken, the six studies that found significant increases of PA can be split up in three studies using exercise interventions, two studies combining exercise and behavioural intervention components, and one study implementing a staff intervention. As types of exercise and behavioral programs differ, programs show few commonalities, hampering their comparison. The fact that the two studies using a combination of exercise and behavioral interventions clearly showed significant increases of PA underlines the potential of this combination. In these two multi-component intervention studies, interventions were characterized by multiple short-time, face-to-face interactions between residents and staff members or research staff/therapists. Thus, one explanation for the positive effect may be that, on one hand, the physical component (exercise) enables NH residents to regain or improve the abilities needed to be physically active. On the other hand, the enhanced individualized contact may be crucial for encouraging residents to use the abilities gained through the physical component, and consequentially lead to more physically active behaviour. This assumption is supported by the fact that the four other studies also included individual supervision and care in some way. In fact, the results and conclusions in five of eight studies imply that exercise linked with individual contact may be the most powerful tool in promoting PA in NH residents. However, the studies do not clarify to which extent each intervention component lead to increases in PA. In the study not reporting any increase of PA, authors trace the absence of effect back to insufficient compliance of residents (Chin A Paw et al. 2006).

With respect to study-quality ratings, it has to be acknowledged that all studies achieved at least half of the maximum score of 16. However, there were methodological weaknesses that may have influenced the evidence of intervention effects. A large variety of heterogeneous PA assessments was used, which impedes an overall interpretation of results. Additionally, psychometric quality of assessments was inappropriately addressed, as only three of the studies provided sufficient information on reliability and validity of PA measures. This might be due to the fact that high-quality PA assessments were either not available or not validated in this population at the time of publication. Hence, caution is in place when interpreting results of these measures.

Regarding objective technical measurement, studies using the most extensively validated uni-axial accelerometer “Actigraph” showed both supportive

and non-supportive findings of PA-promoting interventions. This device has repeatedly been shown to significantly correlate with energy expenditure (EE; Plasqui and Westerterp 2007); however, depending on the kind of regression equations used to calculate EE, it has also been shown to underestimate the objective Metabolic Equivalent of Task (MET; Bassett et al. 2000). The same is also true for the Caltrac motion sensor that tends to underestimate EE in most types of activities except walking (Bassett et al., 2000). No detailed information could be found on the GMM activity monitor used by Fiatarone et al. (1994) as well as the device used by Schnelle et al. (2010), which was not named by the authors. Considering that the studies were published between 1995 and 2014, differences and weaknesses of objective technical PA measurements cannot be excluded even though motion sensors represent a rather recent method of PA assessment. This may also explain why most of these assessment tools have not been validated in NH residents, although the devices used were state of the art at the time of their application.

Observation and questionnaire-based data showed heterogeneous results and most methods lacked validity data. Moreover, they were not stated to be developed for and validated in cognitively impaired subjects, although these were included in most studies. The LASA Physical Activity Questionnaire used by Chin A Paw et al. (2006) was found to moderately correlate with a pedometer (Stel et al. 2004). The Nursing Home Life Space Diameter (NHLSD), used by Grönstedt et al. (2012), gives information on extent and frequency of mobility. According to its developers, it represents a simple assessment of mobility that holds potential to be a universal measure of activity level (Tinetti and Ginter 1990). Generally speaking, elaborated PA assessment methods are required to be highly sensitive and unobtrusive, especially in NH residents. Hitherto, no standard on the assessment of PA has been established and too many different parameters aiming to describe PA are used. Objective technical PA assessments seem to be the method of choice given the problems associated with subjective assessments in cognitively impaired participants.

Limitations

Several limitations of this review should be noted. The term “physical activity” is not easy to grasp, and although numerous relevant synonyms of the term had been used, some studies using different terms may have been overlooked. Thus our

broad literature search may not have been able to identify all relevant studies. Additionally, null findings or inconsistent outcomes may not have been published (filedrawer problem), resulting in publication bias. The fact that only one study with main focus on a modification of PA-behavior could be identified implies that conclusions have to be drawn on outcomes that were not the main focus of the other studies. Moreover, as only one study included post-intervention follow-up measurement, the information on sustainability of effects was too limited to warrant any conclusions.

In general, studies showed large heterogeneity regarding type of interventions and methodology, particularly regarding PA assessment. Hence, it was not suitable to conduct a meta-analysis. It should also be mentioned that results on participation and engagement—which involve PA but are defined on a more general level of "activity" —were excluded from this review. Note in this context that our search also retrieved five Non-RCTs fulfilling all other inclusion criteria and several studies on sleep or rest-activity rhythm. However, these studies addressed PA in terms of sleep patterns or rest-activity rhythms instead of PA; i.e., the outcome measures they used did not exactly fit the inclusion criteria of this review. Therefore, these studies were excluded.

Conclusions

Positive effects of interventions on PA in NH residents were found. Thus, an implementation of interventions involving different forms of activities, exercise, and behavioral interventions seems feasible and valuable in the very frail NH population, regardless of cognitive status. Interventions including enhanced individualized contact may be the most powerful tool in eliciting remaining physical and motivational resources as well as in promoting PA in sedentary NH residents. Therefore, the inclusion of staff into the process of PA behaviour modification may be very useful. With the exception of one study, results were derived from RCTs in which activity promotion was not the major focus. Therefore, we recommend concentrating on such a behavioral perspective in future studies.

Considering assessment tools, sufficient psychometric quality is indispensable. Moreover, a consensus on PA measurements is required to allow comparison of results, as of now there are various parameters used to describe PA. Technically advanced PA assessment devices have recently been developed to provide detailed objective and quantitative as well as qualitative analysis or even life

space assessment, documenting location and area of activities. Such assessments may also be used to gather longitudinal data in order to document the natural course of PA behaviour in NH residents. This could help designing effective long-term interventions with the aim to promote PA in the NH setting.

Overall, results indicate a high potential of multi-component intervention programs to enhance PA in NH settings. Extensive individual contact and attention combined with physical exercise and behavioral programs on the residents' part as well as the inclusion of nursing staff seem to be the most effective components of interventions aimed at PA modification.

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Table 2: Study Characteristics, Intervention, Outcome Measurements, Main Findings (concerning PA), and Quality-rating Score

Study	**Design** No. (N); Age: mean (SD); Cognitive status (MMSE score), Measurement times (times), Followup	**Intervention** No. of IGs (Description); No. of CGs (Description); Duration (Dur); Frequency	**PA as prim. or sec. outcome: description**	**PA Outcome Measurement**[1]	**Main findings** (effects of intervention)	**RCT Rating**	**ES** (d_{Korr}; Klauer 2001)
RCTs							
Chin A Paw 2006 NED	*N*=157. *Age:* 81 (6) *Cognitive Status*: NA *Times:* Baseline, 6 months *Followup:* NA	3; IG I: resistance training, IG II functional-skills training, IG III both interventions. *CG*: 1; educational program. *Dur and Freq:* 26 weeks, 2 days/week.	*Sec.:* habitual PA	accelerometer MTI model 7164 (3 days)	n.s. diff. between groups. Decline of moderate intensity PA* in IG I	12	NA
Fiatarone 1994 USA	*N*=94. *Age:* 87 (1) *Cognitive Status*: IG I: 20.9; IG II: 22.7; IG III: 23.1; CG: 22.2 *Times:* Baseline, 1 week, 10 weeks *Followup*: NA	3; IG I high-intensity progressive resistance training, IG II nutritional supplement, IG III both. *CG*: 2 groups; CG I: placebo activities, CG II: nutritional supplement. *Dur and Freq:* 10 weeks, 3 (IG I)/7 (IG II) days/week	*Prim.:* PA level	activity monitors (GMM) (72 h)	*diff in PA between IG I and III vs. CG I and II	10	NA
Galik 2014 USA	*N*=103. *Age:* 83.7 (9.9) *Cognitive Status:* 8.7 *Times:*Baseline, 3 months, 6 months *Followup:* NA	1; function-focused care intervention. CG: function-focused care education only. *Dur and Freq:* 6 months, 10 hrs/week (IG); 1 30-min in-service (CG)	*Prim.:* PA	accelerometer (ActiGraph; 24 hrs), observational survey (PAS-LTC)	* diff. in PA between groups after 6 months for both measures	15	NA
Grönstedt 2012 SWE, NOR, DEN	*N*=266. *Age:* 85 *Cognitive Status:* IG: 19, CG: 19 *Times:* Baseline, 3 months *Followup*: NA	1; individually tailored physical and daily activities. *CG*: 1; usual care *Dur and Freq:* 12 weeks, 7 days/week	*Sec.:* PA level	Nursing Home Life-space Diameter (NHLSD) rating scale	*diff in PA level between groups	13	NA

Lobo 2010 POR	*N*=137. *Age:* IG: 75-82; CG: 78 *Cognitive Status*: ≥ 24 *Times:* Baseline, 12 months *Followup*: 3 months	3; IG I: aerobic training, IG II strength training, IG III health education program. *CG*: 1; waiting control. *Dur and Freq:* 52 weeks, 2 days/week	*NS:* daily PA	accelerometer MTI Actigraph (7 days, counts/h)	*diff in PA levels between IG I and II vs. CG; n.s. at follow-up	8	IG I vs. CG: 0.992 IG II vs. CG: 0.846
Schnelle 1995 USA	*N*=76. *Age:* 85 (8) *Cognitive Status*: 11.6 *Times:* Baseline, 8 weeks *Followup*: NA	1; prompted voiding plus functional incidental training *CG*: 1; prompted voiding *Dur and Freq:* 8 weeks, 5 days/week, 4x/day	*NS:* PA	motion sensors Caltracs (3x 8 hrs), staff observations	*diff in PA within both groups (IG and CG), n.s. between	9	NA
Schnelle 2010 USA	*N*=112. *Age:* IG: 86 (10,5); CG: 86 (9,4) *Cognitive Status*: IG: 9,6; CG: 12,9[×] *Times:* Baseline, 3 months *Followup*: NA	1; toileting assistance, exercise, and choice of food snacks and fluids. *CG*: 1; usual care *Dur and Freq:* 3 months, 5 days/week	*NS:* PA	movement device (2 days, 8 h)	*diff. in PA between groups	9	NA
Simmons[2] 2004 USA	*N*=89. *Age:* IG: 88 (7), CG: 89 (6) *Cognitive Status:* IG: 12.1, CG: 15.4[×] *Times:* Baseline, 8 weeks, 32 weeks. *Followup*: NA	1; scheduled toileting, encouragement to walk/wheelchair and to repeat sit-to-stands, upper body resistance training, and encouragement to drink fluid. *CG:* 1; usual care. *Dur and Freq:* 32 weeks, 5 days/week, 4x/day	*NS:* daily PA	motion sensors Caltracs (3x 8h), staff observations	*diff. in PA between groups for both measurements	10	1.038

[1]= No study reported significant baseline group differences regarding PA outcomes; [2]=two more papers were published on the same RCT: Kapasi et al. 2003; Schnelle et al. 2002; [a]=assessment of MMSE score insufficient; *=statistically significant (*$p < .05$); [×]=statistically significant at baseline; CG=Control/Comparison Group; ES = Effect Sizes; IG = Intervention Group; LTC=long-term care; NA=not available; n.s.=statistically not significant; NS=not stated whether PA was primary or secondary outcome; PA=physical activity; PAS-LTC: Physical Activity Survey for Long-Term Care;

Table 3: Scores of the study-quality rating

	Score							
Item	Chin A Paw	Fiatarone	Galik	Grönstedt	Lobo	Schnelle 1995	Schnelle 2010	Simmons
Was the assigned treatment adequately concealed prior to allocation?	1	1	1	1	0	1	1	1
Were the outcomes of patients who withdrew described and included in the analysis?	1	1	2	2	0	1	0	1
Were the outcome assessors blinded to treatment status?	2	0	2	2	0	1	0	1
Were the treatment and control group comparable at entry?	2	2	2	2	2	0	2	1
Were care programs, other than the trial options, identical across NHs?	0	0	2	0	0	0	0	0
Were the inclusion and exclusion criteria clearly defined?	2	2	2	2	2	2	2	2
Were the interventions clearly defined?	2	2	2	2	2	2	2	2
Were the outcome measures used clearly defined?	2	2	2	2	2	2	2	2
Sum	**12**	**10**	**15**	**13**	**8**	**9**	**9**	**10**

Manuskript II

Jansen, C.-P., Claßen, K., Hauer, K., Diegelmann, M., & Wahl, H.-W. (2014). Assessing the Effect of a physical activity intervention in a nursing home ecology: a natural lab approach. *BMC Geriatrics,* 14: 117. doi: 10.1186/1471-2318-14-117

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Assessing the effect of a physical activity intervention in a nursing home ecology: a natural lab approach

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Abstract

Background: Physical activity (PA) is not only an important marker of physical impairment, but also a pathway to improve quality of life and enhance cognitive and social functioning of old individuals. Yet, making interventional use of PA training as a means for prevention and enhancement of quality of life of nursing home residents has found very limited attention worldwide so far. That said, the project 'Long-term Care in Motion' (LTCMo) as a part of the INNOVAGE consortium (funded by the European Commission) has the following aims: Overall: Install and assess a socially innovative intervention in the nursing home ecology. Concrete: (a) Conceptualization of a multidimensional intervention program (resident and staff oriented) with the potential to promote PA in nursing home residents; (b) Mixed-methods assessment of the program based on automated recording as well as questionnaire data.

Methods/Design: LTCMo's PA-related intervention has several components which are applied in parallel manner: (1) Residents are engaged in a physical exercise program that is based on multiple approaches: supervised group sessions, a serious games approach, and specific training in severely impaired persons; (2) Staff members will receive a competence training with a focus on PA motivation and facilitation of residents' PA engagement. Primary outcome assessment (movement-related behavior of residents) is completely conducted by means of automated data collection strategies (accelerometer-based activity recording, sensor-based life space recording). This is enriched by a broad range of secondary outcomes (e.g., cognitive performance, depression of residents; behavioral and attitudinal components of staff). Pre-, post- and 3-month follow-up assessment will take place in the target intervention setting as well as in a waiting control condition in which we will also replicate the training and its assessment in a later step.

Discussion: Although we are faced with methodological challenges (e.g., rather small sample size; no randomized control trial), we believe that our approach has something to offer and indeed has some unique characteristics that may have the potential to contribute to the enhancement of nursing home residents' quality of life and at the same time further PA-related research with vulnerable populations at large.

Trial registration: Current Controlled Trials ISRCTN96090441. Registered 31 July 2014.

Keywords: Multidimensional physical activity intervention, Nursing home residents and staff, Mixed methods, Automated activity recording, Psychosocial outcomes

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Background

Nursing home residents are characterized by old age, high prevalence of multi-morbidity, frailty, mobility impairment, severe cognitive deficits, and depression [1]. In terms of day-to-day behavior, an essential feature of nursing home residents is their very low physical activity (PA), even compared to non-institutionalized older adults in advanced old age [2], although there is also a subgroup depicting excess motor activity and wandering behavior [3]. However, PA is not only an important marker of physical impairment, but also a major pathway to improve quality of life and to enhance motor, cognitive, and social functioning in old age. Empirical evidence supports rather large positive effects of PA on a range of important endpoints such as cardiovascular fitness, gait and balance, fall reduction, cognitive function, and well-being in the general older population [4,5]. Moreover, PA training has revealed sizable positive effects in terms of physical and functional ability-related endpoints in those with dementia-related disorders, if efficiently tailored in its application format to the remaining competencies of this specific group [6]. Regarding the nursing home situation, a number of intervention studies, particularly those focusing on intensive muscle training, have shown positive effects in terms of fall reduction [7]. Beyond the fall-related literature, a recent review [8,9] found only 12 intervention studies—though with mixed design qualities—that are able to speak on the effects of PA training in nursing home residents. Although this scarce empirical platform partially supports the assumption of positive effects of PA on a number of endpoints such as increased motor behavior and activity at large, the overall empirical evidence in this area has remained limited and inconclusive.

At the practical and implementation level, a number of barriers making the exertion of PA difficult for nursing home residents have been identified [10]. Residents' low physical and cognitive health and functional status including gait and balance problems and sensory impairments likely hinder residents to imagine that a considerable increase in their PA is possible and feasible without taking too many risks. For the same reasons, staff may refuse to think about encouraging residents to be physically active. Indeed, an intervention to increase PA may increase risk exposure and falls, especially in residents with advanced motor impairment [11]. Psychologically, following the classic idea of 'total institutions' originally described by Goffman [12], many nursing home residents may feel powerless and low in self-efficacy. In addition, staff may have a tendency for dependency-enhancing behavior regarding residents, thus possibly helping too much and fostering independent behavior too less [13]. All in all, these barriers may result in a vicious circle, in which an overall sedentary life style in the nursing home ecology is reinforced because of a variety of reasons, which may lead to additional impairment in functioning in the longer run via disuse processes and a situation of low engagement at large in everyday life [14].

In research terms, a major difficulty of studies on PA conducted in nursing homes lies in the rigorous assessment of PA. In order to assess changes in PA as the consequence of a respective intervention in a reliable and valid way, subjective measures (e.g., interviews, structured questionnaires) may be hampered due to a decline in cognitive abilities or presence of cognitive impairment like dementia, resulting in recall and response biases. Furthermore, especially nursing home residents tend to be engaged in low intensity activities and PA frequently is of short duration and operating on an irregular basis, i.e., short and slow walking episodes are more the rule than the exception. This situation challenges reliable recall processes, particularly in questionnaire-based research [15,16].

Therefore objective assessment by high resolution automated activity recording seems mandatory. In addition to quantitative and increasingly also qualitative assessment of PA, 'life space' assessment has evolved as an important complementary research perspective. PA assessment includes objective documentation of frequency, duration, and temporal course, of movement characteristics such as lying, sitting, standing and walking. Qualitative data analysis including risk of falling, number, duration, and qualitative features of standing, walking, and transfer actions become increasingly technically feasible. The life space concept, originally questionnaire-based [17], has found its automated recording extension by using sensor installations in the target physical ecology [18], allowing for objective assessment of the physical-spatial context, in which movements take place (e.g., frequency and duration of use of public vs. private locations). The combination of both of these assessment strategies hold promising and complementary research options which have, to our knowledge, not been used in the nursing home ecology so far.

Finally, the kind of PA intervention has to be determined that suits the requirements of the nursing home ecology best, given the range of barriers as described above [19]. Although it seems reasonable to rely on the overall positive evidence and practical experiences gathered with classic PA-enhancing training modules applied to vulnerable older populations such as people with dementia (PWD [6]), additional training components may be advisable. In particular, it may be helpful in motivational as well as stimulus enrichment terms to consider new, creative, and fun-evoking training procedures that may particularly suit nursing home life. For example, training strategies based on a 'Serious Games' approach may be a promising addition to focused PA group training programs [20]. Such game-based training typically addresses both motor and cognitive performance. For example, a music-supported stepping task may focus on

dynamic postural control, which is mandatory for motor key features such as standing or walking and represents the most effective training approach with respect to fall prevention in older persons [21]. Cognitive training elements of Serious Games-based PA training may relate to cognitive sub-performances such as temporo-spatial orientation, executive functions, timing/reaction time, action in inhibition, attention-related motor cognitive (dual-) tasks, representing important features for motor control and early markers of cognitive decline. Furthermore, given the critical role of staff in the nursing home ecology, it seems helpful to back a direct nursing home residents-oriented PA intervention with staff-based training elements which focus on the significant role of staff as motivational and PA-reinforcing agents [13,22].

In sum, although PA-related training strategies have considerable potential to enhance quality of life of nursing home residents and potentially also enrich the nursing home as a professional work environment, the respective research literature is very limited. This is where the project 'Long-term Care in Motion' (LTCMo) starts from.

Project aims

LTCMo is part of the INNOVAGE consortium funded by the European commission [23]. In line with the major focus of the European Commission to raise Healthy Life Expectancy (HLE) and overall quality of life of older adults, INNOVAGE aims to showcase a range of social innovations able to contribute to this overarching goal. Within the INNOVAGE architecture, LTCMo addresses the situation of the highly vulnerable older nursing home population and aims to install and assess a respective socially innovative intervention in the nursing home ecology. Driven by the idea of a 'natural lab', we are heading for a procedure that comes with innovative and—compared to previous research—significant improvements in terms of its intervention approach as well as its assessment concept. Study aims include:

1. Conceptualization of a multidimensional intervention program operating at different levels of the nursing home ecology with the potential to promote PA behavior in nursing home residents intensively involving residents as well staff members and by these means efficiently counteracting the existing barriers which typically prevent PA exertion.
2. Development of an innovative assessment strategy to comprehensively assess residents' PA behavior as well as intervention effects, respectively. This assessment concept represents the natural lab component of LTCMo's social innovation and makes an attempt to unify a practical and hopefully quality of life-enhancing strategy (i.e., the multidimensional intervention) with an ambitious and innovative research and measurement concept in the nursing home setting. The assessment concept as a whole is envisaged to be as reliable, valid, cost-effective, and unobtrusive as possible.
   2.1. Residents' habitual PA behavior is comprehensively depicted using objective assessment methods, i.e., accelerometer and life space sensor-based data.
   2.2. Assessment of the intervention effects should include pre-, post-, and 3-month follow-up measurement occasions to estimate the short and long-term effects of the intervention in exemplary manner. There is a waiting control condition consisting of a second nursing home ecology, in which at the first stage of assessment no intervention program is conducted to document the natural course without interventional effects.
3. Disseminate findings as intensively as possible based on a guidebook containing a detailed description of the intervention program as well as findings and practical recommendations able to enhance the implementation process of the intervention in nursing home ecologies at large.

Methods/Design

Description of intervention

LTCMo's PA-related intervention has multiple components which are applied in parallel manner: (1) Residents engage in a physical exercise program that is based on multiple approaches: supervised group sessions, a serious games approach, and specific training in severely impaired persons. Its bottom line is a rigorous focus on functional and strength exercises to improve key motor qualifications necessary for mobility, autonomy, and motion security, i.e. standing, walking, sitting down and standing up. It suits as much as possible the needs of the fragile nursing home population; (2) Staff members receive a competence-enhancing training with a focus on PA motivation and facilitation of residents' PA engagement. To permanently maintain intervention effects, staff is trained to implement training strategies in daily NH routine.

Physical exercise training

The exercise intervention of LTCMo relies on long-standing experience and existing evidence of successful PA interventions in old, multimorbid adults with and without cognitive impairment [6,24,25] and is at the same time specifically tailored to the needs of the target population of physically and cognitively impaired nursing home residents. The supervised training programs used in this study significantly increased functional and cognitive performance and did not lead to adverse events, neither in long-term use in comparable clinical settings nor in previous intervention studies of the research group [6,24,25].

Supervised group sessions & Specific training in severely impaired persons. The 45-minute sessions are offered twice a week over a 12-week period in small groups of four to eight residents. Training intensity is increased according to individual progress. To ensure homogeneity, group composition is determined according to residents' motor and cognitive status, i.e., based on impressions and results derived from performance-based tests and cognitive screening at baseline testing. The exercise sessions are supervised by trained sports scientists to support motivation/adherence and to prevent adverse events such as falls. Trainers are instructed to use communicational strategies developed for use in patients with cognitive impairment. Residents with distinct behavioral problems resulting in disturbance of exercise activities or residents with advanced postural deficits are not included in exercise group sessions. However, they are still eligible for an individual training (Specific training in severely impaired persons) which is based on exercises used in the group training and adapted to the individual abilities of the participants in a one-to-one training situation.

Serious Games Approach. In general, exercise training is based on repetitive and standardized training tasks, which guarantee effectiveness, but may fail to attract all participants. The serious games approach provides an alternative mode to motivate these persons to be active with high effectiveness, supported by a "serious", evidence-based exercise task. The game is constituted as a dual motor/cognitive task. The motor task is based on a progressive functional task (stepping/dynamic postural control) representing the most effective training target for fall prevention [21,26,27]. The cognitive task targets different cognitive sub-performances such as divided attention, temporo-spatial orientation, reaction time, and executive performances, which are early markers of cognitive decline [28] and risk factors for falls [26,27,29]. For part of such cognitive tasks, trainability has been proven [25].

In the current study we use a stepping video game which is based on a modified version of "StepMania dance and rhythm game" [30], see Figure 1. It is constituted as a cognitive-motor training in which the exercise character is substituted by a game character. It will be conducted in small groups of 3-4 residents with only one person playing at a time, supervised by a sports trainer or a trained research assistant. To play the game, the participant has to stand on a dance plate which is connected to a computer via USB. The dance video game screen is projected on a TV screen. A scrolling display of squares moving up, down, right, or left across the screen cues each move and participants have to execute the indicated steps (forward, backward, right, or left) when the squares reach corresponding squares at the top, bottom, right, or left side of the screen (see Figure 1). Participants will have to alternately perform 10 levels of 90 seconds duration each. Difficulty is individually tailored as the program depends on previous individual performance level to prevent overtaxing of users. The standardized program was adjusted to the performance level of frail older adults with and without cognitive impairment in pilot testing prior to the intervention.

Physical activity-enhancing competence training for staff

The major aim of the staff centered PA-enhancing competence training is to enable staff members to interact

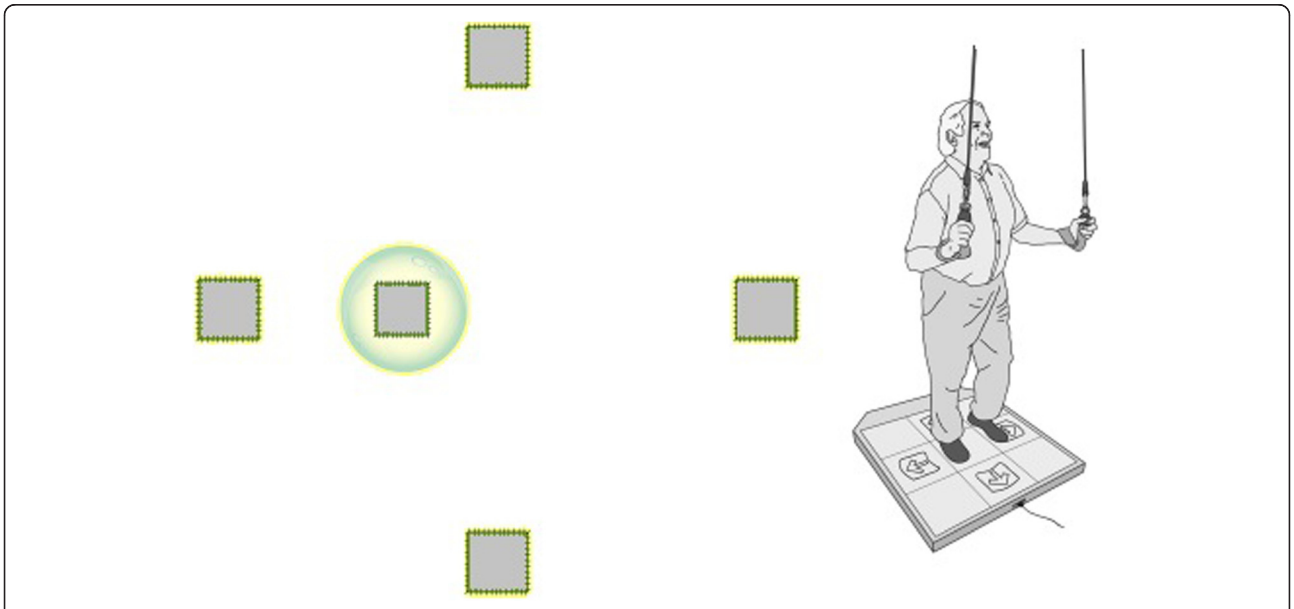

Figure 1 Screenshot of the game and stepping platform [30].

with residents in a way that encourages their PA as much as possible. The conceptual background of the staff training is based on established models of the role of person-environment interactions in long-term care institutions and the significant role of staff [22,31] as well as on psychological models of health psychology (e.g., Self-Determination Theory [32]); Theory of Planned Behavior [33]; Health Action Process Approach [34], self-regulation theory (e.g., Social Cognitive Theory [35]); model of selective optimization with compensation [36]; dependency-support script [13]); life-span motivational models (e.g., Socioemotional Selectivity Theory [37]); positive messaging [38]). Staff members receive intensive information on the role and evidence related to PA in later life and also regarding the role of negative aging stereotype and concomitant underestimation of residents' remaining competencies (e.g., [39]). Emphasis is also put on the importance of barriers and facilitators of being physically active and on ways to overcome such barriers in most creative ways. To achieve this goal, staff learns how to use communication and interaction techniques able to encourage residents to be more active (e.g. positivity, motivational interviewing; see also conceptual background above). Based on role play technology and bed-site trainings, staff intervention is also enriched by extensive practice opportunities. In addition, the practical application of communication strategies in caring routines with the goal to develop strategies for upcoming challenges and to monitor the achievement via feedback-loops is a major issue in the later part of the training program and intents to increase the transfer of what has been learned to day-to-day interactions with residents.

The staff training component is served within the framework of the existing regular in-house training schedule and comprises a total of 12 sessions with one session weekly thus amounting to a duration of approximately three months: Eight 1-hour-sessions including theoretical as well as practical contents and four 30-minutes-sessions mainly serving as case discussions. Each session is offered twice a week to facilitate staff attendance due to their revolving shift involvements. An overview of the full program is given in Table 1. Training sessions are planned for a group format of 15 to 20 persons.

Table 1 Contents and sequential flow of the PA-enhancing competence training for staff

Session	Content
1	Introduction and overview over training program
2	Importance of physical activity in (old) age: Theoretical input and joint discussion
3	The art of behavior change: Theoretical input and joint discussion
4	The role of age stereotypes in caring routines: Theoretical input and joint discussion
5	Communication strategies I: Theoretical input and practical exercises
6	Communication strategies II: Theoretical input and practical exercises
7	Communication strategies III: Practical exercises
8	Feedback on practical application of communication strategies in caring routines and development of respective solutions
9	Case discussion and development of respective solutions
10	Case discussion and development of respective solutions
11	Case discussion and development of respective solutions
12	Case discussion and development of respective solutions

Research design and sample recruitment

Figure 2 depicts our research design. We conduct a quasi-experimental pre-post-assessment study with baseline measurement (T1), measurement at the end of the intervention period (T2), and measurement at the end of a 3-month follow-up (T3) in two nursing homes in the Heidelberg area (Germany). In one nursing home a run-in period (T0) will be conducted, documenting status and course without intervention (T0 vs. T1). One nursing home serves as target intervention facility, whereas the other serves as a waiting control condition. Inclusion criteria for residents' assignment to the intervention are:

1. Permanent resident in included nursing homes
2. Written informed consent (resident/legal representative)
3. For participation in exercise sessions: Ability to stand (supervised group training) or ability to walk (stepping video game). Residents not fulfilling this criterion are still eligible for participation in the assessment procedure.

Exclusion criteria for residents' intervention participation are:

1. Short-term resident in one of the two nursing homes
2. Behavioral problems resulting in disturbance of exercise activities (with respect to participation in group sessions only).

For residents with severe motor impairment (supervised ability to stand) and challenging behavior, training with one-to-one supervision will be established.

All staff members willing to participate are eligible for inclusion. Residents and staff members not willing to participate in the intervention, but providing informed consent and willing to provide pre- and post-assessment information may be used later as a 'natural' control group component in addition to the planned control condition.

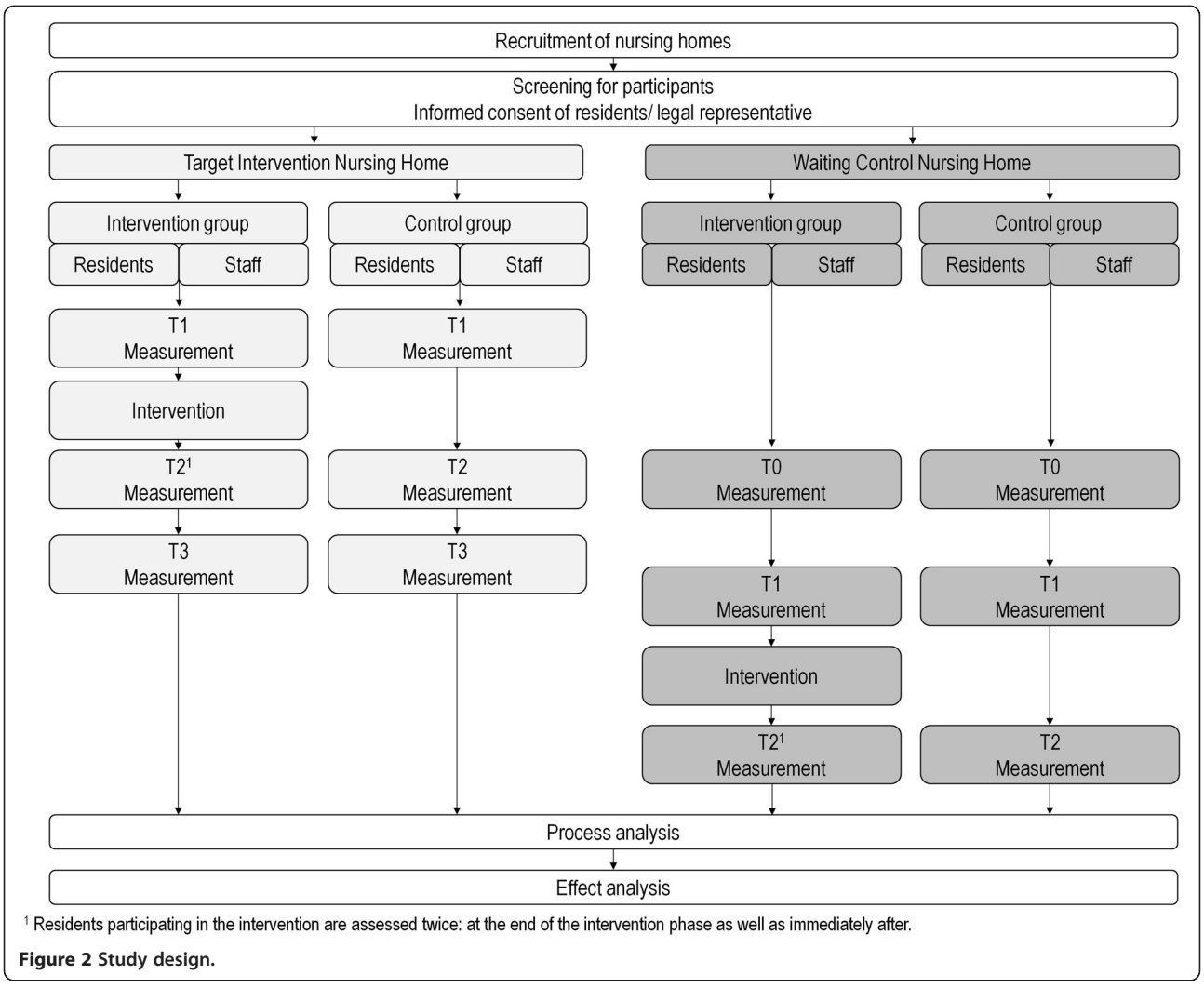

Figure 2 Study design.

As this project has the ambition to assess residents in a 'natural lab ecology' of two nursing homes as comprehensively as possible and to include a relative maximum of residents based on our specific approach, we refrain from any formal power calculation. However, we made sure by selecting two homes with more than 100 residents each that complete assessment of at least 50 participants per home will be possible, assuming a drop-out rate of about 50%. Hence, we currently expect about 50 residents in the target intervention setting and about 50 in the waiting control condition. In addition, we expect about 20 staff members to become part of the staff training component and a similar magnitude to serve as controls.

Prior to the onset of the intervention, assessments in terms of self-reports, proxy ratings, performance-based measures, accelerometer, and life space sensor-based data as well as staff data (self-reports only) are conducted (T1). In both facilities, a small group of three staff members is trained to provide the proxy ratings for *all* participating residents (inter-rater reliability will be examined). In the intervention facility, assessments will take place in the final week of the intervention period (PA and life space assessments only) in order to analyze direct effects of the intervention on PA, immediately after the intervention period has been completed (T2), as well as three months after completion of the training (follow-up, T3) by the comprehensive assessment battery. In the waiting control facility, baseline assessment (T0) is followed by a run-in period to document the natural course without intervention. The assessment protocol for the following intervention and post-intervention phase is otherwise identical to the protocol as described above for the first intervention facility.

The process analysis addresses the setting conditions, implementation, and receipt of the intervention as well as its feasibility. Several means of a process analysis are employed to assess the sampling and intervention quality, e.g., characteristics that may cause selective sampling of participants (e.g., residents' depressive symptoms) are documented as well as the frequency of participation, questionnaire-based evaluations of each staff training

session, and supervision of staff's application of learned techniques. The effect analysis addresses the effectiveness of the intervention components regarding the described outcomes.

Informed consent and ethical approval

Residents' relatives, legal representatives, and staff members were intensively informed about the study based on written material as well as oral presentation. To ensure the comprehensibility of the information sheet for residents, two of its versions were already pretested in another nursing home. The version chosen was attested to be comprehensible and of appropriate length. Information events were held for relatives, staff members, and residents. Additionally, staff members were informed during their shift changes. Written informed consent was requested in residents and their legal representatives before the onset of the study (in case those were nominated for persons with severe cognitive impairment).

Ethic approval for the project was obtained from the Ethic Review Board (ERB) of the Faculty of Behavioral and Cultural Studies of Heidelberg University with an approval letter dating from December 19, 2012 (no number or code is provided by the faculty's ERB)[a]. Two amendments also obtained ethical approval: one addressing the implementation of a sensor system for life space assessment of nursing home residents to monitor activity in publicly accessible areas (letter dating from February 24, 2014), the other addressing the possibility to share our PA data with other data platforms, such as a world-wide documentation of fall events (letter dating from May 28, 2014).

Measures

All variables identified as primary and secondary outcomes as well as additional variables potentially moderating possible outcomes will be collected from each participant in the intervention condition at the three time points (see Figure 2).

Outcome measures

A classic assessment challenge in nursing home residents is their highly limited capacity for testing/self-reporting. Therefore, the ambition to make extensive use of automated recording tools of PA also comes—besides its advantages in terms of reliability and validity—with reducing the load of self-reporting. This is further enhanced by referral to proxy ratings, although it is clear that time capacity of professionals in nursing homes is limited and thus proxy ratings must be as short as possible. Besides, major variables that require self-report are assessed in the shortest version possible, without losing quality in terms of reliability and validity in an unacceptable magnitude.

Primary outcome measures: residents

Physical activity assessment. The primary outcome assessment relies on automated activity and life space recording. Duration and frequency of residents' *PA* (i.e., lying, sitting, standing, and walking) is recorded using triaxial accelerometers (uSense) fixed at the lower back for 48 consecutive hours. The sensors are non-commercial prototypes, developed by the EU-funded "Farseeing" project (fall detection) and allowing detailed quantitative as well as semi-qualitative data analysis.

Life space assessment. Residents' *life space* is measured objectively using the innovative wireless sensor network method s-net® [40]. Sensors (anchor nodes) are placed in the nursing home and each resident wears a corresponding sensor (end nodes) to track his or her position in time and space continuously. Each battery-operated end node calculates and signals its position at approximately 20 second intervals. The surrounding anchor nodes gather and forward this information to the destination (gateway node connected to the back-end system) according to a communication protocol. This protocol guarantees the network's energy efficiency and its self-organization, and thus its robustness in the naturalistic setting. Data concerning residents' covered distance, the duration spent at defined locations and the frequency of changes of locations will be assessed.

Life space assessment parallels PA assessment, i.e. different PA data based on automated recording allows simultaneous recording and combined data analysis.

Secondary outcome measures: residents

At the level of performance-based outcome measures, well established clinical tests are conducted. The *Short Physical Performance Battery* (SPPB [41]) is used to assess lower extremity functioning (balance, gait, strength, and endurance). The SPPB requests residents to stand side-by-side, semi-tandem, and full-tandem, for 10 seconds each, to walk a distance of four meters at maximum speed using their walking aid if necessary (two attempts with the better performance being scored), and to perform five timed chair stands with their arms folded across their chest. Each task is scored on a 0-4 scale. Zero points are given if the subject is unable to complete the task. An overall score ranging from 0-12 is created by summation of scores. In addition to the SPPB, the *Timed Up & Go* test [42] is performed. Residents are asked to stand up from a chair, walk three meters (using their walking aid if necessary), return to the chair, and sit down again as fast as they can. With respect to *gait speed,* residents are asked to walk 10 meters at maximum walking speed, using their walking aid if necessary (two attempts with the better performance being scored). The conventional analysis of clinical test data is backed up by a high-tech, qualitative analysis of parameters (DynaPort® Hybrid, McRoberts).

The unobtrusive device will be fixed to the residents' lower back during the test using an elastic belt.

To allow target-specific objective assessment of Serious Game performance and progress, we use the technical data flow of the device for customized assessment. This technically advanced assessment strategy is in line with the high technical standard of assessment used for PA and motor performance in this study, allowing a detailed and comprehensive insight in effects of motor training. In sum, all data assessments regarding PA and physical performance rely on automated recording.

Falls are documented according to a standardized definition [43]. Data on *frequency of falls* is obtained from the nursing homes' care documentation and standardized questions which participants are asked twice a week. Further, the *Short Falls Efficacy Scale* (Short FES-I [44]) is conducted to assess residents' concerns about falling. The FES-I has also been validated for use with cognitively impaired persons.

In addition to automated recording and performance-based assessment, we ask staff members to provide a proxy rating on the care and behavior assessment regarding wandering, security measures (restraints, e.g., bed rails, safety belt), frequency of social situations (e.g., visits, staff contact) and activity participation of target residents [45]. Data concerning security measures, falls, and activity participation will be complemented with information from the nursing homes' care documentation.

Residents' care level will serve as an indicator for their need of assistance with activities of daily living (ADL). It is assessed by the German Health Insurance Medical Service (MDK), varies from 0 *no need of care* (i.e., need for assistance required for less than 90 minutes per day on average) to 3 *in constant need of care* (i.e., need for assistance required around the clock, on average at least for five hours per day). The care level will be taken from the care documentation. Additionally, residents are asked to provide an overall rating on how they perceive their ADL independence based on a single-item approach, i.e. the question "How would you assess—all things considered—your self-dependence?" The answer format is 0 *fully depending on help* to 10 *fully independent*. The item has been proven useful in prior research with older adults as an addition to classic ADL assessment [46].

Concerning the cognitive assessment, the well-established Mini-Mental State Examination (MMSE [32,47]) will be used. The MMSE is a commonly used and easy to apply screening method and represents a comprehensive screening method including different cognitive sub-performances. In order to also have an external examination of cognitive performance available, MMSE assessments are complemented by the proxy Dementia Screening Scale (DSS) for use by nursing home staff [48]. Staff members rate residents' memory (e.g., Could he/she remember what happened in the past few days?) and orientation (e.g., Could he/she orient him-/herself in his/her room?) in seven items. The scale proved to be a valid screening tool for proxy use in nursing homes.

We assess *depression* based on the established 15-item *Geriatric Depression Scale* (GDS-15 [49]). The scale has been developed for use in geriatric and vulnerable samples and offers a simple, dichotomous response format; it has also been validated for use with persons with mild-to-moderate cognitive impairment [50-52]. Self-reports on depression will be complemented by a staff-based proxy rating, using the Montgomery-Åsberg Depression Rating Scale (MÅDRS [53]), documented by trained staff members. This task is taken over by trained staff members, i.e., those who know the target residents very well. These raters were endowed with precise explanations of the items' contents to enhance inter-rater reliability. The scale consists of 10 sevenary items asking for apparent and reported sadness, inner tension, reduced sleep, reduced appetite, concentration difficulties, lassitude, inability to feel, pessimistic, and suicidal thoughts. The MÅDRS has also been validated for use as proxy-assessment for depression of residents in nursing homes [53].

Residents' satisfaction with life is assessed using a single-item approach, i.e. the question: "How satisfied are you at the moment with your current life?" The answer format is 1 *fully unsatisfied* to 5 *fully satisfied*. The item has been proven useful in prior research with older adults [54].

Furthermore, we assess apathy by use of the *Apathy Evaluation Scale* (AES-D [55-57]) that requires a proxy rating of residents according to 10 statements representing symptoms of apathy (e.g., interest in new experiences, approach to life with intensity, or having initiative).

Finally, we assess how residents perceive their activities as well as their social life. Regarding the former, six items taken from the *Pleasant Events Schedule—Nursing Home Version* (PES-NH [58,59]) and three additional items in the same format allow residents to provide information on the occurrence as well as on how pleasant they find a given activity. Residents' perceived social integration is assessed based on the 3-item social loneliness subscale of the established De Jong Gierveld Loneliness Scale [60-62].

Potentially moderating variables: residents

Variables that may potentially moderate the training effect are seen on four layers: First, self-efficacy may be important, i.e. residents with higher self-efficacy may profit better from PA training. An economic approach is an ultra-short version of *general self-efficacy* (ASKU [63]), in which residents' are required to answer only three questions on their general self-efficacy. The scale has been tested psychometrically in several large samples and reference values stratified by age,

sex, and education are provided [63]. Second, regarding control beliefs, we use an ultra-short *locus of control scale* (IE-4 [64]); residents are asked two questions on their internal as well as two questions on their external locus of control. The scale has been tested psychometrically in several large samples and reference values stratified by age, sex, and education are provided [64]. Third, we also ask residents to provide their *subjective age*, that is, whether they feel older or younger compared to their calendar age. Subjective age has been found to be significantly related to a number of health outcomes as a recent meta-analysis revealed [65]. Fourth, we make an attempt to assess the overall *motivation to move* based on two single items asking for internal and external motivational forces.

Demographic variables and overall health assessment: residents

In terms of demographic variables, we assess residents' age, sex, marital status, parenthood, years of education, and nursing home entry. For a global health assessment, residents will answer single-item questions on their capacity to move, eyesight, hearing, and whether daily functioning is impaired due to pain. The scale for these questions ranges from 1 *very bad* to 5 *very good* and 1 *extremely* to 5 *not at all*, respectively.

For sample description and use as covariates we document residents' diagnoses, medication, and BMI using data from the nursing home's care documentation.

Secondary outcome measures: staff

The staff training is meant to impact residents' PA and additionally to result in a perceived change in professional competence related to PA promotion in residents. To assess this secondary outcome, staff members rate their perceived nursing competency using 18 items from a questionnaire on nursing competence established in Germany (German title: Fragebogen zur pflegerischen Handlungskompetenz [66]). In addition, staff motivation when interacting with residents (e.g., preference for dependence- or independence-supportive behavior, discouraging or encouraging of residents' activity participation) will be assessed using nine self-developed items, because no established instrument exists in this area. Sample items include "I prefer to have a resident sit in a wheelchair to prevent her/him from falling.", "I involve residents in ADL as much as possible, even though this takes more time.", or "I motivate residents to leave their rooms and meet others." For all assessments, staff members are asked to complete the respective questionnaire at home.

Because not only a change in staff behavior towards residents, but also a possible impact on staff members' attitudes towards their work is expected due to staff training, the following variables are also assessed: *Work-related consequences of strain* (e.g., difficulty relaxing after work) are measured using the 8-item Irritation Scale [67-69]. *Job satisfaction* will be assessed with a single-item approach, i.e. the question "Overall, how satisfied are you with your job?". The answer format is 1 *not at all* to 5 *very much*. It is also assumed that staff's own perceived aging experiences may be touched by the training. Therefore, their *subjective age* ("Some people feel older or younger than they actually are. Apart from your real age, how old do you feel most of the time?") and their *expectations regarding their own aging* by using the *Expectations Regarding Aging Survey* (ERA-12 [70,71]) are assessed. The survey includes questions on expectations regarding staff member's own aging in physical health, mental health, and cognitive function domains. Finally, staff's age stereotypes in the domains of "friends and acquaintances", "leisure activities and social or civic commitment", "personality and way of living", and "physical and mental fitness" are rated based on the domain-specific age stereotypes questionnaire suggested by Kornadt and Rothermund [72].

Demographic variables: staff

At baseline, information on age, sex, marital status, parenthood, and years of education is collected.

Discussion

Physical training has been established as a major tool for prevention of the occurrence of a range of diseases and loss of functional impairment as well as rehabilitative approaches such as maintaining autonomy, cognitive performance, and the reduction of depressive mood [73]. Although nursing home residents belong to the lower end of the competence continuum in advanced old age, there is no fundamental reason to question such a positive effect in this population. Indeed, one may argue that the nursing home ecology comes with particular advantages in terms of implementing a PA regimen able to improve residents' quality of life. For example, reachability of target persons for imposing a PA program is rather easy in the "concentrated ecology" of nursing homes, given that the administrative structure has given its commitment to unfold such an intervention. In addition, staff as significant others of residents and well-established, powerful change agents [13] may take over the role of a motivational partner in a highly contingent way, if they receive a respective PA-enhancing training component. That is, the critical part of every PA training in old age (and in other periods of life), i.e. translating an enhanced PA behavior pattern into the turbulences of day-to-day life, may find a particularly suitable, if not ideal platform in the nursing home ecology. Seen in a wider perspective, we believe—as part of the INNOVAGE consortium—that a respective intervention has the potential of a social

innovation at large, that is, the shaping of nursing home ecologies toward the better by bringing them more into "motion."

To achieve this goal, we are currently executing a theory-driven multi-dimensional training program in a nursing home under what we are labeling a natural lab condition. The training follows a multi-dimensional approach and explicitly unifies components of resident-oriented PA training, Serious Games elements, and staff-oriented competence enhancement. As a consequence of our vulnerable target population, primary outcome assessment is completely conducted by means of automated data collection strategies. This strategy is enriched by a broad range of secondary outcomes that rely on proxy ratings, performance-based measures, and self-report data based on answering formats that are simplified as much as possible without questioning the reliable and valid assessment of study variables. In addition, we also assess a range of staff-oriented variables to examine the possible impact of our staff training on staff behavior and attitudes. Going further, we are installing a waiting control condition based on a second nursing home ecology with two intentions: First, the waiting control signifies natural trajectories of outcome measures over time; second, we plan to replicate the training program and do respective pre- and post-assessments after the intervention part has been completed in the target nursing home.

That said, it is obvious that such a design should be seen as a *demonstration study* and comes with a number of challenges and limitations. First, we expect rather small sample sizes in the magnitude of 50 residents and 20 staff members, however, hope to double the intervention-oriented sample sizes in the waiting control group by replication of the training program. On the other hand, we will generate a data space with these small samples that—to our knowledge—currently does not exist worldwide. For example, we will assess different dimensions of resident motion in space and time based on automated recording and performance-based variables. Indeed, we regard our assessment as a rather unique combination of detailed quantitative and semi-qualitative PA data in combination with life space data which are not available so far to our knowledge for this population. Envisaged secondary data analysis will also be possible, such as the relation among depression and activity in nursing home residents.

Second, considerable missing data at the various levels of assessment is expected and we are also facing the challenge of potentially invalid self-report data. Here, we hope that such missing data can be "compensated" to a major extent by using different data layers. For example, self-report data obviously will not play the key role in our resident population and will be "compensated" by the automated recording efforts. Third, it is clear that we are not following the strict criteria of a RCT format. That is why we talk about a demonstration study research design that will of course need replication based on a stronger design at a later point in time, if emerging results are promising. Fourth, we purposefully are not intending to separate the possible differential effects of the various intervention components. Fifth, we see the data-analytic challenges coming with our demonstration study design. At first glance, it seems obvious that we have quite an imbalance between data density and number of variables and sample size. However, intensive data collection based on intensively observed smaller sample sizes is emerging in many areas of behavioral and health research in aging and beyond and many innovative statistical procedures have been suggested to optimally treat such a data situation [74,75].

In sum, although we clearly see the challenges ahead, we believe that our approach has something to offer and indeed has some unique characteristics that may have the potential to contribute to the enhancement of nursing home residents' quality of life and at the same time further PA-related research with vulnerable populations at large.

Endnote

[a]In Germany, ERBs are not always assigning numbers to their decisions. This is also true in our case.

Abbreviations

ADL: Activities of Daily Living; ERB: Ethic Review Board; HLE: healthy life expectancy; LTC: long-term care; LTCMo: Long-term Care in Motion; MÅDRS: Montgomery-Åsberg Depression Rating Scale; MMSE: Mini-Mental State Examination; PA: Physical activity.

Competing interests

The authors declare that they have no competing interests.

Authors' contributions

Each of the authors contributed relevant material based on accepted practice and knowledge in their respective disciplines. All authors took part in preparation of the manuscript and provided critical intellectual interpretation and manuscript revision. All authors read and approved the final manuscript.

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Life-space and movement behavior in nursing home residents: results of a new sensor-based assessment and associated factors

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Abstract

Background: Studies on life-space (LS) and its determinants have previously been limited to community-dwelling subjects but are lacking in institutionalized older persons. The purpose of this study was to provide an advanced descriptive analysis of LS in nursing home residents and to identify associated factors based on an established theoretical framework, using an objective, sensor-based assessment with a high spatiotemporal resolution.

Methods: Cross-sectional study in two nursing homes in Heidelberg, Germany ($n = 65$; mean age: 82.9 years; 2/3 female). Changes of location in the nursing home (Transits) as well as time spent away from the private room (TAFR) were assessed using a wireless sensor network. Measures of physical, psychosocial, cognitive, socio-demographic, and environmental factors were assessed via established motor performance tests, interviews, and proxy-reports.

Results: LS of residents was largely restricted to the private room and the surrounding living unit (90%); 10% of daytime was spent outside the living unit and/or the facility. On average, TAFR was 5.1 h per day (±2.3; Range: 0–8); seven Transits (6.9 ± 3.2; Range: 0–18) were performed per day. Linear regression analyses revealed being male, lower gait speed, higher cognitive status, and lower apathy to be associated with more Transits; higher gait speed, lower cognitive status, and less depressive symptoms were associated with more TAFR. LS was significantly increased during institutional routines (mealtimes) as compared to the rest of the day.

Conclusions: The sensor-based LS assessment provided new, objective insights into LS of institutionalized persons living in nursing homes. It revealed that residents' LS was severely limited to private rooms and adjacent living units, and that in institutional settings, daily routines such as meal times seem to be the major determinant of LS utilization. Gait speed, apathy, and depressive symptoms as well as institutional meal routines were the only modifiable predictors of Transits and/or TAFR, and thus have greatest potential to lead to an enhancement of LS when targeted with interventions.

Trial registration: Current Controlled Trials ISRCTN96090441 (retrospectively registered).

Keywords: Life-space, Nursing home, Sensor-based assessment, Spatiotemporal movement behavior

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Background

Considerable efforts have been made to increase quality of care and quality of life in nursing home residents (NHR) in the past decades [1, 2], but physical and social inactivity still remain a large concern in modern nursing facilities. As research has shown, the majority of NHR spend their time inactively sitting or lying alone [3, 4]. A measure that has been positively associated with physical activity as well as social participation in community-dwelling older adults [5, 6] and NHR [7] is life-space (LS). LS has been conceptualized as the spatial extension of an individual's environment that he/she moves in during a specified time period [5, 8], irrespective of the types of conducted activity, use of walking aids, or other assistance [9]. In general, greater LS implies that an individual has more opportunity to visit personally meaningful places and to interact socially with others [10]. To highlight the complexity of factors influencing LS in older adults, Webber et al. [11] presented a theoretical framework in which LS mobility in old age is assumed to be influenced by cognitive, psychosocial, physical, socio-demographic, financial, and environmental dimensions. The model has found partial empirical support in previous research which has demonstrated associations between LS mobility and physical performance [8, 12, 13], global cognitive functioning [14], and psycho-social factors including depression [12, 13, 15], concerns about falling [16], and apathy [13] in community-dwelling older persons.

Applying the LS framework in NHR—an institutionalized group of older persons with multiple impairments—poses the question whether the determinants identified in community-dwelling older subjects can also be verified for LS in NHR. Institutions such as nursing homes (NH) are expected to have pronounced characteristics that strongly determine life and behavior within them [17]. Such characteristics are, for example, architectural features (e.g., special care units, meeting places); care routines; or institution-dependent organizational schedules including meal times and weekly recurring and highly standardized events [18, 19]. That said, we assume that the framework of Webber et al. (2010) may largely be valid also for the NH setting, but needs additional qualification in that the institutional factors impacting on behavior may play a key role in determining LS.

LS has mostly been assessed in- and outside of the private home environment [8, 9, 12, 20]. Self-report measurements as the *Life-Space Diary* [8], the *University of Alabama at Birmingham Study of Aging Life-Space Assessment* [12], or the *Life-Space Questionnaire* [9] were predominantly used, providing a composite score of LS across a defined time period. Regarding NHR, only one measure has been introduced to our knowledge, a proxy-rating titled *Nursing Home Life-Space Diameter* (NHLSD) [19]. Such subjective LS assessments—self- or proxy-ratings—come with multiple weaknesses, e.g., recall/response biases, especially in cognitively impaired subjects [21–23]. Moreover, they are unable to identify changes or events with temporal precision and intra-individual specificity [24]. Also, predictors of LS may operate differently in more global questionnaire data as compared to high resolution data. This is why increasingly objective, technical LS-related assessments [13, 20, 25] (e.g., Global Positioning System, infrared motion sensors, or Bluetooth transmitters) are used which also provide a high spatiotemporal resolution of LS not achievable by questionnaire-based assessment. However, such an advanced assessment strategy has so far not been applied in the nursing home setting. Specifically, a continuous, real-time assessment with high spatiotemporal resolution and minimal intrusion of the daily activities of individuals allows a more accurate picture of LS dynamics in daily ecologies and thus higher ecological validity. It may also become important as an endpoint in intervention research or serve diagnostic purposes by adding information to clinical status assessments.

This study provides a new sensor-based LS assessment in an institutional setting, including automated, high-resolution, spatiotemporal recording of residents' habitual movement behavior within the resident facility across daytime. The aim of this study is threefold: (1) We provide a highly accurate picture of NHR' LS and movement behavior, not achievable by previously used assessments. (2) Based on the theoretical LS framework of Webber et al. (2010), we examine whether its LS determinants are applicable to the nursing home setting and allow to develop a model explaining variance in NHR' LS. (3) Given the unique characteristics of institutions described above, we hypothesize that, in addition to the factors described by Webber et al., a large proportion of the variance in NHR' LS will be attributable to institutional routines, i.e., scheduled mealtimes.

Methods

Design

The present study is based on cross-sectional data from Long-Term Care in Motion (LTCMo, ISRCTN96090441, [26]). Ethical approval for the project was obtained from the Ethic Review Board of the Faculty of Behavioral and Cultural Studies at Heidelberg University. The study was conforming to the respective policy and mandates of the Declaration of Helsinki. Either residents or their legal representative provided written informed consent.

Participants

Participant characteristics are presented in Table 1. Participants were permanent residents of two comparable nursing homes in Heidelberg, Germany, that were

Table 1 Participant Characteristics and Descriptive Statistics on LS Data

	N	Mean (SD)	Range
Age [years]	65	82.9 (9.6)	53–98
Sex [female / male]	43 / 22		
Length of stay [years]	65	2.2 (1.7)	0–8
Nursing Home 1 / 2	27 / 38		
Open / code-secured unit	53 / 12		
MMSE [score]	58	18.0 (8.1)	2–30
AES-D [score]	65	15.4 (8.7)	0–28
GDS-12R [score]	56	3.0 (3.3)	0–11
FES-I [score]	55	9.5 (3.2)	7–21
Max. gait speed [m/s]	61	0.57 (0.50)	0–1.99
Ambulatory status	65		
walk without aid	15		
walk with aid	29		
wc, self-propelled	10		
wc, immobile	11		
Time spent in Z1 [h]	65	2.93 (2.33)	0–8
Time spent in Z2 [h]	65	4.30 (2.39)	0–8
Time spent in Z3 [h]	65	0.47 (0.61)	0–2.24
Time spent in Z4 [h]	65	0.31 (0.81)	0–4.13
TAFR [h]	65	5.07 (2.33)	0–8
Transits [n]	65	6.9 (3.2)	0–18

Abbreviations: *AES-D* Apathy Evaluation Scale, *FES-I* Falls Efficacy Scale International, *GDS-12R* Geriatric Depression Scale-Residential, *[h]* hours, *MMSE* Mini-Mental State Examination, *[m/s]* meters per second, *[n]* number, *SD* standard deviation, *TAFR* time spent away from private room, *wc* wheelchair, *Z* Zone

situated in a quiet, suburban residential area, with promenades and supermarkets close by. The surrounding area was easy to access and did not include mobility barriers such as busy streets or hills. Both homes were obliged to newest care standards, run by the same organization and equal in organizational structures, neighborhood, mealtimes, and activity programs. Their architectural conceptualization was equal, which makes both facilities comparable. Both facilities had long hallways along which the private rooms where located; hallways all met in a large public area where meetings and group activities took place and meals were served; easily accessible elevators and stairs allowed transfer to other units on different building levels. Except for those who were terminally ill or received palliative care, all residents were eligible for participation. Of 259 permanent residents in both nursing homes, 137 gave consent to participating in the LS assessment, of which 65 fully completed both measurement days. Reasons for exclusion from analysis were removal of sensors ($n = 13$) or incomplete data due to technical difficulties identified via maintenance software running alongside measurement, i.e., reception disturbance or damaging of hardware by NHR ($n = 36$); measurement interruption due to a power breakdown one morning ($n = 21$); and measurement inaccuracy, i.e., the system could not distinguish between zone 1 and 2 in residents having their private room next to the dining area ($n = 2$).

Data collection

In order to achieve an advanced descriptive analysis of LS, s-net® technology (Fraunhofer Institute for Integrated Circuits IIS, Erlangen, Germany [27, 28]) was used in both nursing homes. This technology uses mobile nodes (end nodes) that determine their position at 30 s intervals based on Received Signal Strength Indicator (RSSI) values. RSSI values were calculated based on received messages from wireless communication. An infrastructure of anchor nodes was built within the building as position references for the network's routing function. The anchor nodes were evenly distributed on outside walls at height of approximately 2.3 m in both nursing homes, spanning a polygonal area within which end nodes could determine their position (Fig. 1). To ensure identical density of anchor node distribution in both facilities, 72 anchor nodes were distributed in nursing home 1 and 151 anchor nodes in nursing home 2, due to the different size of the buildings. Anchor nodes were configured with fixed positions that were broadcasted periodically during measurement, operating on a transmission frequency of 868 MHz. End nodes being within broadcast range of anchor nodes received these messages and measured their signal strength. From three to 16 received reference positions of anchor nodes a weighted centroid was calculated, being defined as the estimate of the end node's position. The weights were derived from the measured RSSI values such that the calculated position was closer to the anchor nodes with higher signal strength. The calculations were based on the underlying algorithm (Weighted Centroid Location; WCL [29]). RSSI measurements can be severely affected by multipath fading and shadowing on end nodes, resulting in fluctuations of measured values. To address this issue, s-net® localization contains filter components for pre- and post-processing of measured values. Validation of the system showed a mean deviation of 2.28 m (range: 0.3–4.6 m) of the end nodes' physical position [28].

After the system components had been installed in the nursing homes, the network's connectivity was tested and warranted before measurement started. During the first four measurement days, a Fraunhofer technician monitored communication between sensors using maintenance software that could immediately identify technical problems or failure of single sensors. Due to network capacities, a maximum of 22 participants at a time were equipped with sensors for two consecutive days; the average of both days was used for the analyses.

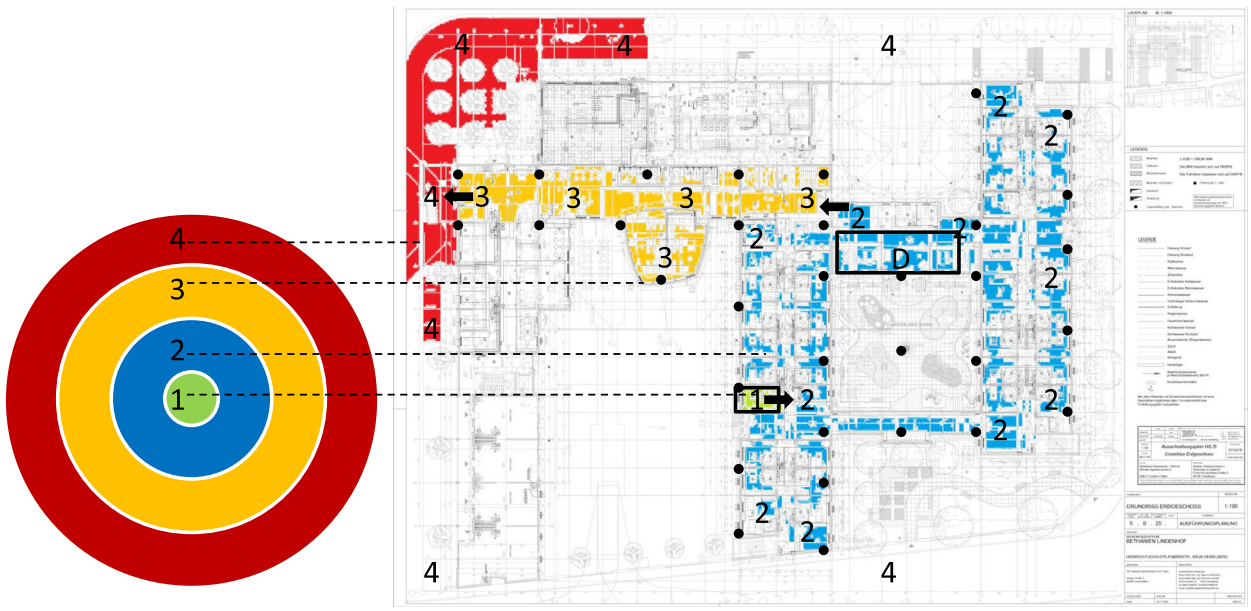

Fig. 1 Overview of one nursing home including the division of life-space into four hierarchical zones. Hierarchical zones are delineated as concentric circles as defined by Tinetti & Ginter (1990). *Black dots* indicate positions of wireless receivers of the measurement system, encasing the whole building; Zone 1 (*green*) stands for the private room; Zone 2 (*blue*) stands for the whole living unit in which the private room is located; Zone 3 (*orange*) stands for the public area outside the living unit but within the facility; Zone 4 (*red*) delineates the whole area outside the facility. *Arrows point* out passages between zones. Zone 1 (exemplary private room) is bordered with a *black frame*. The dining area within Zone 2 is marked with a "D" and bordered with another *black frame*

Residents were visited on normal weekdays and equipped with one end node each morning as soon as they left their private room and entered the public dining room. They kept the end node until they returned to their private room in the evening after dinner. To achieve comparability between subjects, LS data were analyzed for each participant from 10 a.m. to 6 p.m. (hereafter referred to as "daytime").

Several steps were taken to control for actual end node wearing time. During measurement, participants were visited every two to three hours to ensure adherence to measurement protocol. In addition, nursing staff were asked to immediately report on lost/found end nodes in order to follow up on reasons for loss or to continue measurement if appropriate. If position reports of end nodes were not received steadily according to maintenance software, end nodes were immediately checked. If participants had not worn end nodes constantly during measurement, they were excluded from analysis. In case of occasional gaps where end nodes were without reception within the network, the duration of these gaps was added to the duration of the preceding episode. This was based on the assumption that an end node is more likely to regain reception as soon as the person wearing it changes her/his location.

Based on previous research [19], the nursing home life space was hierarchically structured into four zones (Fig. 1): private room (Zone 1); outside the room but within the living unit (Zone 2); outside the living unit but within the facility (Zone 3); outside the facility (Zone 4).

Using a previous analytic concept to operationalize LS in community-dwelling persons [20], two LS-parameters were derived from LS raw data to describe relevant behavioral features of residents' spatiotemporal movement in the nursing home environment: the time residents spent away from their private room (TAFR) and the frequency of LS zone changes (Transits).

Cognitive Factors. Cognitive Status was assessed using the *Mini-Mental State Examination* (MMSE) [30].
Psychosocial Factors. Psychological status was assessed by established assessment methods validated in persons with cognitive impairment or in NHR (12-item *Geriatric Depression Scale—Residential* (GDS-12R) for depression [31], *Apathy Evaluation Scale* (AES-D) [32–34] for apathy, and the *Short Falls Efficacy Scale International* (Short FES-I) [35, 36] for fall-related self-efficacy [37].
Environmental Factors. TAFR and Transits during institutionally scheduled mealtimes—including 15 min transfer time before and after—were extracted to operationalize institutional routines. Unscheduled LS was defined as TAFR and Transits during the rest of the daytime. In total, institutionally scheduled mealtimes constitute 2.7 h of the overall measured daytime (8.0 h).

Physical Factors. Based on observations and staff information, residents were rated regarding their *ambulatory status* as *(a)* ambulatory without aid, *(b)* ambulatory with aid, *(c)* self-propelled wheelchair user, and *(d)* fully immobile wheelchair user. Gait speed was assessed with a *10 m walk test* at maximum walking speed, using a walking aid if necessary.
Socio-Demographic Factors. Age, sex, and length of stay in the facility were assessed using the care documentation.

Data analysis

Descriptive LS analysis included mean, standard deviation, and range for all variables. Relative strength of associations between LS measures (TAFR and Transits; average of both measurement days) and independent variables were determined by linear regression models. Variables were considered for inclusion into the regression models based on structural coherence with the dimensions described in the LS mobility framework by Webber et al. (2010), except for financial factors which, as we assume, play no role in our sample. Given our rather small sample size, predictors that were not correlated with the criterion variables (bivariate correlations of either r or $rho < .2$ and $p > .10$; Table 2) were not included in the models; only one factor was included for each dimension. To avoid multicollinearity in case of several factors of the same domain being correlated to dependent variables, these were included separately in the regression models and the strongest factor was then selected. To explore the association between institutional routines and LS, we repeated the regression analysis but controlled for the variance of Transits and TAFR during institutionally scheduled mealtimes. Regressions were based on full information maximum-likelihood (FIML) estimations which consider all available data from all respondents, thus avoiding selective case deletion and maintaining sample size-dependent power. FIML provides unbiased estimations given that data is missing at random and multivariate normal [38]. To account for non-normality, we used a robust maximum likelihood estimator. Dependent t-tests for paired samples were computed to analyze differences between LS during institutionally scheduled mealtimes and unscheduled daytime. All statistical analyses were performed using SPSS for Windows (IBM SPSS Statistics for Windows, Version 23.0. Armonk, NY: IBM Corp.) and Mplus version 7.31 [39].

Table 2 Bivariate Correlations Between LS-Measures and Predictor Variables

	TAFR	Transits
Age [years]	−.10	−.15
Sex	−.07‡	.36**‡
Length of Stay [years]	.01	.08
MMSE [score]	−.47***	.34**
Gait Speed [m/s]	.51***	−.28+
GDS-12R [score]	−.35**	.15
FES-I [score]	−.36**	.28*
AES-D [score]	.09	−.28*
Ambulatory Status	.08‡	.13‡

Abbreviations: *AES-D* Apathy Evaluation Scale, *FES-I* Falls Efficacy Scale International, *GDS-12R* Geriatric Depression Scale-Residential, *MMSE* Mini-Mental State Examination, *TAFR* time spent away from private room, *wc* wheelchair, *yrs* years, † Pearson r, ‡ Spearman rho
+ = <.10; * = $p < .05$; ** = $p < .01$; *** = $p \leq .001$

Results

Descriptive life-space statistics

According to the s-net® measurement protocol, approximately 62,400 position reports were received during the study, which is equal to 480 observations of each NHR's position per day [62,400 / (65 NHR × 2 days)]. Results of the LS measures TAFR, Transits, and the average duration of stay in the four LS-zones (displayed in Table 1) on both days show that LS of residents was to a very large extent restricted to the private room (zone 1: 2.93 h = 36.6% of the daytime) and the immediate area around it (zone 2: 4,30 h = 53,8%). On average, NHR spent only 0.47 h (=5.9%) outside the own unit but within the facility (zone 3) and only 0.31 h (=3.8%) outside the facility (zone 4) per day. Three quarters of the residents went beyond their living unit and one quarter left the facility at least once during both measurement days. On average, almost seven Transits (6.9 ± 3.2; Range: 0–18) were made. Only two residents (3.1%) never left their room whereas 22 residents (33.8%) spent less than one hour in their room during daytime. Intraclass Correlation Coefficients (ICCs) showed fair agreement between both measurement days for Transits (.41) and strong agreement for TAFR (.76).

Figure 2 shows residents' LS with spatial *and* temporal resolution, i.e., the percentage of residents measured in each LS zone across the daytime.

Predictors of life-space in NHR

Results of bivariate correlation analysis are presented in Table 2; results of linear regression analyses in Table 3. Male sex, lower gait speed, lower apathy, and higher cognitive status were associated with higher amounts of Transits and jointly accounted for 27% of the variance ($p = .002$). Apathy and cognitive status, however, were not significant in the regression model.

In the model for TAFR, higher gait speed, lower cognitive status and less depressive symptoms were significantly associated with more TAFR. The model accounted for 43% of the variance ($p < .001$). Although

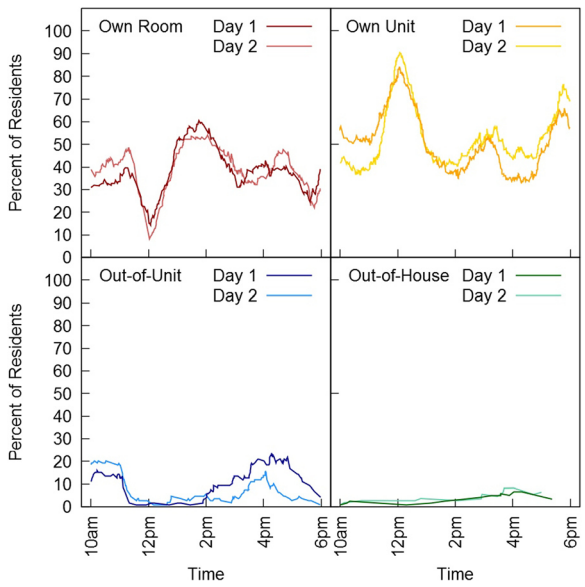

Fig. 2 Percentage of NHR in each of the life-space zones across two measurement days. Most resident Transits occurred during lunch time between 11.30 a.m. and 1.00 p.m. and during dinner time around 5.20 p.m. and 6.00 p.m. The only time frames in which several residents left their own living unit were between 10 a.m. and lunch and between 2 p.m. and dinner (see Fig. 2). The highest number of residents (8%) was located outside the facility around 4 p.m

concerns about falling were significantly correlated with TAFR, Short FES-I scores were not included in the final model as they explained less of the variance than GDS scores and did not contribute more to the overall variance explanation of the model.

Table 3 Linear Regression Analyses—Models for Transits and TAFR

	β	SE	Sβ
Transits			
Sex	3.02**	1.03	.34**
Gait Speed	−2.27*	1.14	−.21*
AES-D	−.10	.07	−.21
MMSE	.07	1.14	.13
R^2			.27**
TAFR			
Gait Speed	2.34***	.61	.38***
MMSE	−.10***	.03	−.36***
GDS-12R	−.14*	.07	−.20*
R^2			.43***

Abbreviations: *β* raw β, R^2 overall R^2 of each model, *Sβ* standardized β, *SE* standard error, *AES-D* Apathy Evaluation Scale, *GDS-12R* Geriatric Depression Scale-Residential, *MMSE* Mini-Mental State Examination, *TAFR* time spent away from private room

$^{+}p < .10$; * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$

LS and institutional routines

When subsequently included in the models, TAFR and Transits during institutionally scheduled mealtimes showed a very strong effect on overall TAFR and Transits. TAFR during these explained almost 80% of the variance of the overall TAFR ($R^2 = .80$, $\beta = 2.83$; $p < .001$), leaving all other predictors insignificant. A similar effect was observed for Transits ($R^2 = .67$, $\beta = 1.78$; $p < .001$). During institutionally scheduled mealtimes, residents spent significantly more TAFR per hour than during unscheduled daytime (70.0% vs. 59.8%, $t = 4.24$, $p < .001$) and performed more Transits per hour (1.58 vs. 0.69, $t = 11.35$, $p < .001$).

Discussion

To the best of our knowledge, this is the first study to explore LS in NHR based on objective, sensor-based assessment with a high spatiotemporal resolution. Key findings of the current study were that (1) LS was very limited in NHR; (2) factors belonging to dimensions included in the framework by Webber et al. (2010) are also applicable to the NH setting; (3) when included in the models, the strongest association was found between overall LS variables and institutionally scheduled routines such as mealtimes.

Following the methodological paths of key studies in the field of LS research [8, 9, 12, 19], we took a different practical approach by using a sensor-based system to obtain a comprehensive and objective picture of LS in NHR. Unlike subjective assessments used in previous studies, our objective assessment approach is not limited to generating a composite LS score, but also provides data on the chronological order in which LS areas where visited and for how long. This allows investigating LS far more extensively than before, including aspects of daily movement behavior in a sample of highly vulnerable NHR with high prevalence of advanced motor and cognitive impairment.

Despite the rather tight corset of the daily structure in institutions like nursing homes, data analysis revealed a wide spectrum of LS, ranging from residents who permanently stayed in their private room to those who were permanently absent from their room during daytime (see Table 1). Due to the lack of LS-related research in the nursing home setting, there are no results available for comparison with our findings on the duration a subject spent at a certain room or the frequency in which s/he changed zones on a daily basis in NHR. Results from studies using the NHLSD [7, 19] are hardly comparable as this measure is conceptualized as composite LS score regarding the past 2 weeks. When compared to independent-living seniors, NHR perform considerably less Transits (6.9 per day vs. 10.8 room changes per hour) and spent muss less time out of the house (0.3 h

per day vs. 4.0 h per day) [20]. It has to be taken into account that in these two groups, the different LS zones have a different connotation, e.g., TAFR for a NHR still means staying indoors, whereas time away from home for an independent-living subject means leaving the building.

Our data shows that the main part of NHR' daily life unfolded on the living units. Only very few individuals left their unit or facility and thus were not engaged in any activity beyond the facility at all. This is in line with Goffman (1961), who pointed out that institutions such as nursing homes are characterized by a "barrier to social intercourse with the outside" (p. 4). Some NHR may be worried by the thought of entering a less controlled, rather unknown and unsafe area beyond their unit. Others may feel drawn out of isolation in their room towards more eventful places. As a result, most NHR mainly stay in the public areas of their living units—a behavior which may also be attributable to motor and cognitive impairment of NHR.

Results from linear regression analyses confirm the LS-related dimensions identified by Webber et al. (2010) in their framework as well as findings in previous studies [8, 12–16]. In line with previous studies that found male sex being associated with larger LS mobility [40, 41], male sex was associated with more Transits in our sample.

Regarding motor performance, we found conflicting results on the association between LS and gait speed. Whereas more TAFR was associated with higher gait speed, more Transits were associated with lower gait speed. Thus, residents with better walking abilities change LS areas less frequently but stay in zones 2 to 4 for longer periods of time. One explanation may be that NHR with inferior walking abilities and functional capacity need to take rest periods in their private rooms more frequently than those with better physical function. We see this contrasting association of functional performance with both LS parameters as an indicator of different underlying concepts of both parameters requiring further investigation.

Our finding that lower cognitive status and less depressive symptoms were associated with TAFR finds support in results on community-dwelling subjects regarding the time out of home [20, 42]. Lower cognitive status was associated with more TAFR and less Transits in our sample. Cognitively impaired subjects probably feel drawn to public areas due to certain aspects of these areas that draw attention (e.g., noise or conversation) [43]. Due to diminished wayfinding abilities (i.e., not finding their own private room and staying where they presently are instead), or a high prevalence of apathy, they are often bound to stay in such public areas or other already determined locations. Cognitive performance may also reflect staffs' reaction to these symptoms of dementia, that is, to keep residents in sight in the public area, and thus a larger amount of time is spent in public areas away from the own room, and less Transits are performed [44]. However, beta weights were not significant for MMSE scores in the Transits regression model. The same applies to beta weights for apathy, with lower apathy being associated with more Transits, as previously reported in community-dwelling subjects [13]. To explore this insignificance, we examined these linear regression results more closely. We found that AES-D scores were significantly correlated with MMSE scores (Pearson's $r = -.558$; $p < .001$). When eliminating one of both measures from the regression model, the other factor became significant (AES-D: standardized beta = −.280; $p = .005$; MMSE: standardized beta = .253; $p = .045$), indicating that AES-D and MMSE have a considerable proportion of shared variance explanation. This is not surprising as apathy is a key symptom of dementia [45].

As expected, the strong association between institutional factors and LS became very clear. When controlling for the variance of Transits and TAFR during institutionally scheduled mealtimes in separate models, it explained 67% (Transits) and 80% (TAFR) of the variance of Transits and TAFR during overall daytime, even though it only stood for one third of the overall measurement time. In the presence of these control variables, all other predictors included in the final models became insignificant, which demonstrates the high association between the variance of LS parameters during mealtimes and overall variance, adding valuable information regarding the structure of the Webber et al. framework when applied in the nursing home setting. That is, when comparing institutionally scheduled mealtimes with unscheduled daytime, considerable differences in LS parameters were found. During institutionally scheduled mealtimes, there were twice as many Transits per hour and TAFR was more than 20% higher. This has several implications: First, institutionally scheduled time is a rather "active" time, as it requires the majority of otherwise rather sedentary residents to move (or be moved) to the dining area and to be around others in a social context. Compared to this active time, NHR actually tend to be less active when they can freely decide what to do, e.g., participate in optional social group activities. Second, it implies a restriction of LS in terms of its *range*, as NHR have to be *inside* and *within* the living units during these institutionally scheduled mealtimes if they want to be served their meal—unless they are invited and picked up for a meal by friends or relatives.

Several limitations of the study have to be noted. Although the sensor-based assessment provides an objective documentation of LS, this technological approach comes with some technical limitations, especially

regarding gaps in data transmission. Due to the systems localization frequency of one per 30 s, Transits within this time frame could have been missed if more than one had occurred. However, due to the low gait speed and motor function of our sample, more than one Transit within 30 s is a rather unlikely event. As a relatively high number of participants had to be excluded from analyses, the study sample was limited and thus potentially underpowered for certain research questions. Some of the independent variables are based on self-report measures, which may have been affected by recall and response bias due to cognitive impairment or other factors such as depressive symptoms. The study design was intentionally inclusive, also including a minor group of persons being unable to move independently. However, we see LS as an objective reality, irrespective of its active or passive occurrence.

Some valuable practical implications arose from our study. With a view to the associated factors found in this study, and by identifying the individual movement patterns of each resident during the day, our assessment approach may also be suitable for documenting deterioration in motor function and development of depression or behavioral symptoms related to dementia such as apathy (manifesting as 'never leaving the private room') or wandering/restlessness (manifesting as 'moving around constantly'). The fact that NHR are particularly inactive between meals shows the good occasion in the daily schedule for implementing physical activity and LS enhancing interventions. These should be focused on associated factors that are susceptible to intervention (especially gait, apathy, and depressive symptoms), and be carried out on the living units in order to be within reach of the majority of residents who do not go beyond their living unit. Overall, the sensor-based LS assessment is a good example of how new assessment strategies may provide new and more comprehensive insights into the movement behavior of NHR. As it is still undergoing further development, the sensor-based LS assessment promises to capture more complex parameters that may be derived from raw data in the future, e.g., distance travelled within the facility as a measure of physical activity. Our approach may also help in identifying architectural and environmental characteristics of NHs such as dangerous, fall-provoking spots or important meeting places, and unfrequented, deserted areas in the facility, allowing enrichment of the environment and further stimulation of NHR' social participation in daily life.

Conclusions

As derived from a sensor-based measurement for indoor localization, the LS of NHR was mainly limited to private rooms and living units. The LS framework by Webber et al. has proven useful in the NH setting as LS was associated with predictors similar to those previously identified in studies with community-dwelling subjects. However, it requires modification in that daily routines such as meal times should be included as a determinant in institutional settings due to their high impact on residents' LS as revealed in regression models. Gait speed, apathy, and depressive symptoms as well as institutional meal routines were the only modifiable predictors of Transits and/or TAFR, and thus have the potential to lead to an enhancement of NHR LS and movement behavior when targeted with interventions.

Abbreviations

[m/s]: Meters per second; AES-D: Apathy Evaluation Scale; FES-I: Falls Efficacy Scale International; FIML: Full Information Maximum-Likelihood; GDS-12R: Geriatric Depression Scale-Residential; LS: Life-space; MMSE: Mini-Mental State Examination; n: Group size; NH: Nursing home; NHLSD: Nursing Home Life Space Diameter; NHR: Nursing home residents; p: Significance level; r: Pearson's r; rho: Spearman's rho; RSSI: Received Signal Strength Indicator; SD: Standard deviation; Sβ: Standardized beta weight; TAFR: Time spent away from the private room; wc: Wheelchair; yrs: Years; β: Beta weight

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Availability of data and materials

The raw data is available by email on reasonable request to Carl-Philipp Jansen (corresponding author). E-mail: carl-philipp.jansen@psychologie.uni-heidelberg.de.

Authors' contributions

HWW, KH: study concept and design. CPJ, MD, ELS: study organization and data acquisition. CPJ, MD, HWW, KH: analysis and interpretation of data. CPJ, MD, ELS, HWW, KH: preparation and revision of manuscript. All authors read and approved the final manuscript.

Competing interests

The authors declare that they have no competing interests.

Consent for publication

Not applicable.

Ethics approval and consent to participate

Ethical approval for the project was obtained from the Ethic Review Board of the Faculty of Behavioral and Cultural Studies at Heidelberg University. Either residents or their legal representative provided written informed consent.

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Manuskript IV

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Pushing the Boundaries: A Physical Activity Intervention Extends Sensor-Assessed Life-Space in Nursing Home Residents

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Abstract

Background and Objectives: To determine whether a multi-component, individually tailored intervention to promote physical activity (PA) enhances life-space (LS) utilization in nursing home (NH) residents and whether intervention effects can be sustained at follow-up after implementation of the program into daily institutional routines.

Research Design and Methods: Pre-post assessed controlled trial in two highly similar NHs with a three-month follow-up in 143 NH residents (intervention group: n=78; control group: n=65) and LS as primary outcome. The PA promoting intervention consisted of several components (group exercise; individual exercise; serious games training; competence training for staff) tailored to residents’ individual functional capacity. LS was innovatively assessed via an indoor wireless sensor network including three assessment-specific LS parameters: overall LS score (LSSc), time spent away from the private room (TAFR), and the maximally distal zone from private room visited (MaxZ). To exploit the available intervention-control comparative data in the best way possible, a generalized linear mixed model approach was applied.

Results: At posttest, intervention participants had a significantly higher overall LSSc, spent more TAFR, and had extended their MaxZ as compared to the control group. At follow-up, a significant group difference remained for MaxZ.

Discussion and Implications: A PA intervention in the NH setting impacts on LS utilization as measured using sensor-based assessment. The program has proven its practical sustainability when being handed over to NH personnel for implementation into daily practice. Further research is needed to determine whether an increase in LS utilization also impacts on social participation and quality of life.

Key words: Controlled before-after study; Spatial behavior; Exercise; Implementation

Introduction

A large proportion of older people in need of care are living in nursing homes (NH) in European countries (European Commission (DG ECFIN), 2012), the U.S. (Harris-Kojetin, Sengupta, & Park-Lee, 2016), and Canada (Pitters, 2002). Due to age-related physical and cognitive limitations as well as illness-related functional impairment (E. Phillips, Schneider, & Mercer, 2004; Slaughter, Estabrooks, Jones, & Wagg, 2011), NH residents' range of action is severely reduced, resulting in low activity levels and social participation (Den Ouden et al., 2015; Ice, 2002; Lawton & Simon, 1968).

A research concept that has been directly associated with physical activity (PA) as well as social participation is life-space (LS) (Sheppard, Sawyer, Ritchie, Allman, & Brown, 2013; Tsai et al., 2015; Webber, Porter, & Menec, 2010), which is defined as the spatial extension of the environment that a person utilizes during a specified time period (May, Nayak, & Isaacs, 1985; Tsai et al., 2015). LS has been frequently used as a measure of mobility, reflecting objectively performed mobility in space and time instead of momentary, mobility-related physical capacity (Mackey et al., 2014).

Interventions to enhance LS find theoretical support in the *environmental docility hypothesis*, which states that the less competent an individual is (e.g., in terms of health or social role performance), the more behavioral variance can be attributed to environmental conditions (Lawton & Simon, 1968; Wahl, Iwarsson, & Oswald, 2012). Adding Lawton's concept of *environmental proactivity* to this hypothesis, greater competence of the individual comes along with a better use of environmental resources to satisfy personal needs (Lawton, 1989). Especially in NH residents, competence is often low and can be expected to deteriorate over time (Levy et al., 2016). Consequently, enhancing an individual's competence by means of a PA intervention should result in reduced behavioral dependence on environmental conditions as well as better ability to use environmental resources, and thus allow residents to extend their personal LS. On a social level, such LS extension may enhance quality of life (Choi, O'Connor, Mingo, & Mezuk, 2016) and also help establishing new social contacts, and provide new opportunities for pleasant and emotionally meaningful encounters (Calkins, 2001).

Most of the previous LS-related research has been performed in community settings, indicating associations between LS and physical performance and function (Al Snih et al., 2012; Barnes et al., 2007; May et al., 1985; Tung et al., 2014),

cognitive functioning (Barnes et al., 2007), depression and apathy (Baker, Bodner, & Allman, 2003; Tung et al., 2014), gender and race (Al Snih et al., 2012; Choi et al., 2016), and concerns about falling (Uemura et al., 2013), as well as heterogeneous effects of exercise on LS (Fairhall et al., 2012; Maki et al., 2012). LS in institutional care environments has found very limited attention previously. Although the introduction of the so far only LS assessment in the NH context, i.e. the "Nursing Home Life-Space Diameter" (NHLSD; Tinetti & Ginter, 1990), had been a landmark in this field, such retrospective proxy-assessments fully rely on subjective perceptions of caregivers that are prone to bias (Tung et al., 2014). Moreover, such assessments do not allow identifying LS extensions and respective intraindividual change dynamics with high spatiotemporal precision and specificity (Kaye et al., 2011). To avoid this shortcoming and further develop LS assessment methodology in institutional field settings, we recently applied an objective, sensor-based LS assessment with high spatiotemporal resolution as part of the "Long-Term Care in Motion" (LTCMo) study. In a cross-sectional analysis based on this methodology, we found that LS measures in NH residents were associated with gait speed, apathy, depression, and cognitive status; as expected, LS was also closely related with institutional meal routines (Jansen, Diegelmann, Schnabel, Wahl, & Hauer, 2017). However, it remains unclear whether objectively assessed individual LS and its utilization can be modified by a PA enhancing intervention in the NH setting. Only one intervention study has previously used a LS assessment tool in NH residents (Grönstedt et al., 2013), utilizing a subjective, retrospective proxy-assessment of LS (NHLSD) as a measure of PA. LS and its environmental implications were not considered at all in their study conceptualization.

Concluding, this is the first intervention study with focus on LS modification in NH residents. The aim was to test the efficacy and sustainability of a multi-component, specifically tailored PA intervention program to increase individual LS in NH residents. We expected intervention participants to having increased their LS at posttest and at three-month follow-up, after self-reliant continuation of the program as part of the daily NH routine.

Design and Methods

The LTCMo study (ISRCTN96090441) was part of the InnovAge project, which had the overarching study objective to implement a *social innovation* to promote

healthy and active aging, while providing high applicability and transferability within its social context. LTCMo was conducted in two NHs in Heidelberg, Germany. Ethical approval for the project was obtained from the Ethic Review Board of the Faculty of Behavioral and Cultural Studies at Heidelberg University. The study was conforming to the respective policy and mandates of the Declaration of Helsinki. Either residents or their legal representative provided written informed consent.

Design, Setting, and Participants

LTCMo aimed at providing an initial evaluation of an intervention program under naturally occurring and thus ecologically valid conditions and at examining the program's potential for self-reliant implementation into the daily routines of the facilities after completion of the trial. It was therefore not the aim to test the efficacy of the intervention under fully controlled and idealized conditions using a rigorous randomized procedure. Following a "*natural lab approach*", all permanent, non-palliative residents of both NHs were eligible to participate, including residents with severe functional or cognitive impairment who are often excluded in intervention studies (Taylor, DeMers, Vig, & Borson, 2012). In NH2, a waiting-control condition had been applied; thus, baseline assessments from NH2 were included in the analysis (see Figure 1). Residents who participated in at least one activity intervention session were considered as belonging to the intervention group (PA-IG); all residents who did not participate in any training session were considered as a naturally occurring control group (Nat-CG). Both homes were highly similar as they were located in the same suburban residential area and obliged to newest care standards, were run by the same organization and were equal in organizational structures, activity programs, and architectural conceptualization.

(Figure 1 about here)

Intervention Program

The LTCMo intervention included two different approaches: a multi-component, individually tailored, PA intervention that has proven effective in improving motor performance in multi-morbid older persons with and without cognitive impairment (Hauer et al., 2012; Schwenk et al., 2014), and a competence training for NH staff aimed at becoming more efficient in motivating residents toward higher PA engagement (Jansen, Classen, Hauer, Diegelmann, & Wahl, 2014). The PA intervention aimed at changing NH residents' PA behavior and LS utilization by

promoting motor performance and motivational as well as psychosocial resources of participants. For twelve weeks, residents were either allocated to group training sessions or individually tailored one-to-one training administered by specially trained sports scientists. Moreover, a resident-centered approach was developed, including dementia-specific communication and motivational strategies (e.g., to handle challenging behavior). In addition to group-based or individual training, all residents who were able to stand could participate in a virtual serious games training. To avoid both too excessive and insufficient training load, residents were divided into four different categories based on their motor function: *1)* residents who were ambulatory without aid; *2)* residents who were ambulatory with aid; *3)* residents who were at least able to stand up; *(4)* residents with severe motor impairment. Residents of categories *(1)* to *(3)* were allocated to homogenous exercise groups; those in category *(4)* received individual exercise training. This categorization was performed regardless of affiliation to an open or code-secured living unit. Training intensity was individually adapted and progressed with residents' capabilities.

To foster training sustainability, the program was handed over to activity coordinators of both NHs after completion of the controlled intervention trial. That is, activity-coordinating staff received extensive training to continue the exercise courses as professionally as possible by integrating exercise sessions into their weekly in-home activity schedules. They also received intensive supervision to ensure highest possible implementation quality (Jansen et al., 2015).

Measures

Primary Outcome: Life-space. To objectively assess LS utilization, a wireless sensor-network was installed in both NHs (s-net®; Fraunhofer Institute for Integrated Circuits IIS, Erlangen, Germany; Wenzel, 2014). This technology uses mobile end nodes that constantly determine their position within a wireless communication infrastructure. Residents were visited on normal weekdays and equipped with one end node each morning as soon as they left their private room, keeping the end node until they returned to their private room after dinner. To achieve comparability between subjects, LS data were analyzed for each participant from 10a.m. to 6p.m. To control for actual end node wearing time, participants were checked approximately every two hours and nursing staff were asked to immediately report on non-adherence. If position reports of end nodes were not received steadily according to maintenance software, end nodes were immediately checked. If

participants had not worn end nodes constantly during measurement, they were excluded from analysis. An extensive description of the technology, its technical specificities, and data handling is provided elsewhere (Jansen et al., 2017).

Based on previous research, the NH LS was hierarchically structured into four zones: private room (Zone1); outside the private room but within the living unit (Zone2); outside the living unit but within the facility (Zone3); outside the facility (Zone4) (Tinetti & Ginter, 1990).

Three parameters were derived from LS raw data: a LS score to describe the zone in which each resident lingers on average throughout the day, with larger scores indicating a larger average LS utilization

(formula: $LSSc_i=\sum_{k=1}^{4}\left(k * \frac{(time\ spent\ at\ zonek)_i[s]}{(overall\ measurement\ duration)_i\ [s]}\right)$);

the maximal zone a resident reached (MaxZ=maximum of *k*) as a measure of the overall extent of an individual's LS; and the time a resident spent away from her/his private room (TAFR) as a measure of abode in areas with high potential for social interaction.

Assessment of Additional Variables. For descriptive purposes, age, sex, and length of stay in the facility were assessed via care documentation; cognitive status was assessed using the Mini-Mental State Examination (MMSE); psychological status was assessed by the 12-item Geriatric Depression Scale—Residential (GDS-12R) (Sutcliffe et al., 2000) for depression, Apathy Evaluation Scale (AES-D) (Lueken et al., 2007; Marin, Biedrzycki, & Firinciogullari, 1991) for apathy, and the Short Falls Efficacy Scale International (Hauer et al., 2011) for fall-related self-efficacy. Based on observations and staff information, residents were rated as either mobile (ambulatory or self-propelled wheelchair use) or fully immobile. Gait speed was assessed with a 10m walk test at maximum walking speed, using a walking aid if necessary. The Short Physical Performance Battery (SPPB) was used to assess lower extremity functioning, i.e. balance, gait, and leg strength (Guralnik et al., 1994).

Statistical Analysis

To test the intervention effect on LS utilization in the most appropriate way in the face of our inclusive "natural lab" study design, a generalized linear mixed model (GLMM) approach was applied (Hedeker, 2005). That is, we used a longitudinal multilevel model to analyze the repeated assessments of LS and to test the intervention effects by including post- intervention measurement and follow-up

measurement as dummy predictor variables (i.e., post-intervention = 1 if the LS was assessed after the respondent had participated in the intervention, and 0 for all other LS assessments; accordingly, follow-up = 1 if the LS was assessed 3 months after the respondent had participated in the intervention etc.). This longitudinal GLMM approach provides particular strengths as it facilitates dealing with non-normality of the response variable (modeling, e.g., skewed response distributions such as gamma), and allows for state-of-the-art missing data treatment instead of using listwise deletion (Schafer & Graham, 2002). GLMM is best fit for our inclusive study conception as it considers all available data points of each resident also if certain measurement occasions were missed or residents dropped in at a later stage of the study. In order to reduce measurement error due to non-randomization, potential pretest differences were analyzed using multiple *t*-tests for interval-scaled covariates and Fisher's exact tests for dichotomous covariates. If significant differences between PA-IG and Nat-CG occurred, these were included as covariates into the models testing the intervention effect. A bootstrap step-down adjustment was applied to *p*-values to correct for multiple testing using PROC MULTTEST on SAS 9.4 (SAS Institute Inc., 2011).

The GLMM testing of intervention effect was built on five assumptions: *(1)* A random intercept effect was included, representing "unexplained" inter-individual differences in LS. *(2)* Based on previous findings of age-related decline of LS (Al Snih et al., 2012; J. Phillips, Dal Grande, Ritchie, Abernethy, & Currow, 2015), time-in-study was included as covariate with random effects—i.e., a linear random slope effect, representing an individual's rate-of-change in LS apart of the intervention effects and the impacts of the other controls. *(3)* Despite NHs being comparable, they may still differ substantially in various outcomes, e.g., in their social environment, atmosphere, etc. Therefore, home affiliation was included as covariate in the models to check for different LS trajectories in the facilities. *(4)* Based on the same assumption as *(3)*, we also checked for home-specific intervention effects after the program had been handed over to NH staff by testing *home*×*follow-up* interactions. These were included in the models in case of statistical significance. *(5)* Assuming that drop-ins who had just recently moved into one of the institutions substantially differ from their already long-staying fellow residents in several outcomes, we also controlled for drop-in status. GLMMs were estimated using the gamma link function in

SAS PROC GLIMMIX (SAS Institute Inc., 2011). A more comprehensive description of the statistical method can be found in Diegelmann et al. (2017).

To examine whether intervention effects on LS utilization were attributable to gains in motor function, we conducted a post-hoc examination of the impact of motor performance on LS parameters in a subsample of residents who were able to accomplish the SPPB. To account for the effect of inter-individual differences in motor performance at pretest on all three LS parameters, grand-mean centered SPPB scores were included in the models. Furthermore, to examine the impact of changes in motor performance over time, intraindividual deviations from pretest SPPB were additionally entered as covariates into the models.

Results

Participants

As shown in Figure 2, 103 residents had completed the LS measurement at pretest. Including drop-ins, the overall sample included in the GLMM analysis consisted of 143 subjects. Seventy-eight of these participated in the intervention program: 61 were trained in groups and 17 individually; among these, 17 additionally participated in the virtual serious games training. Adherence was high with 85% in group training sessions, 78% in individual training sessions, and 82% in serious games sessions. From pretest to follow-up, LS data is missing in 45 cases. Reasons for missing LS data were acute medical conditions of residents, premature removal of sensors by residents, and technical difficulties such as measurement interruption due to a power breakdown one morning.

(Figure 2 about here)

Table 1 gives sample characteristics and group differences at pretest. With the exception of MaxZ, there were no significant pre-intervention differences between PA-IG and Nat-CG[5], indicating comparability of both groups. As can be expected in such a highly vulnerable sample, not all measurements could be completed by the participants. Missings for interview data were due to cognitive impairment, aphasia, acute hospitalization, or refusal. Due to severe motor impairment, a substantial

[5] Note that the random intercept effect included in the GLMM on MaxZ implicitly controls for such a priori differences: The models' (fixed) intervention effects denote (average) deviations of the posttest or follow-up MaxZ from the individual trajectories that might "start" at inter-individually varying pretest levels (and rung with inter-individually varying time-in-study-related slopes).

number of participants were unable to perform performance-based tests (see Table 1).

(Table 1 about here)

Results of GLMM analyses are presented in Table 2. Regarding the assumptions guiding the development of the GLMM stated above, we found a significant linear decline over time-in-study for LSSc (β_1=-.02, p=.007) and MaxZ (β_1=-.04, p=.011), but not for TAFR (β_1=-.02, p=.277) (assumption *(2)*). No significant differences between NHs were found (assumption *(3)*). The only significant *home*×*follow-up* interaction (assumption *(4)*) was found for the MaxZ model (β_5=-.35, p=.038). Regarding assumption *(5)*, we found that drop-ins were significantly different from already included participants in MaxZ (β_6=.47, p=.009), but not in LSSc (β_6=.17, p=.081) and TAFR (β_6=.33, p=.295).

(Table 2 about here)

Intervention Effects on LS

Figure 2 displays the schematic trajectories of the models for all three LS parameters over all measurement occasions in NH2, including the waiting-control condition that had been applied in NH2 only. When controlling for NH affiliation, time in study, and drop-ins, LS parameters of PA-IG in both homes increased from pre- to posttest, whereas the assumed steady decline of LS parameters was confirmed for LSSc and MaxZ in the Nat-CG. PA-IG participants had a significantly higher LSSc (β_3=.13, p=.003), spent more time away from their own room (TAFR; β_3=.28, p=.015), and had a more extensive LS (MaxZ; β_3=.29, p=.003) as compared to the Nat-CG (see Table 2).

(Figure 2 about here)

Except for MaxZ at follow-up, the intervention effects on LS remained significant in the subsample of n=71 residents who completed the SPPB. For all three dependent variables, changes in SPPB as well as inter-individual differences at pretest did not predict LS at posttest.

Intervention Effects at Follow-up

Sustainability of intervention effects at follow-up was found for MaxZ (β_4=.39, p=.012), marginally for LSSc (β_4=.11, p=.065), but not for TAFR (β_4=.15, p=.361). While LSSc and TAFR declined from posttest to follow-up in the PA-IG, MaxZ was maintained within this period. The significant *home*×*follow-up* interaction for MaxZ

(β_5=-.35, p=.038) showed that sustainability of intervention effects was dependent on NH affiliation, i.e., PA-IG participants in NH2 had a more beneficial MaxZ trajectory from posttest to follow-up than those in NH1. This dependence was not found for LSSc and TAFR.

Discussion and Implications

This study showed the beneficial effect of a multi-component, individually tailored PA enhancing intervention on LS utilization of NH residents. There were two innovative elements connected with the study: to the best of our knowledge, this is (1) the first intervention study with a clear focus on LS modification in this setting; (2) the first study using an objective, sensor-based assessment method to identify intervention effects in terms of detailed spatiotemporal LS utilization as objectively as possible.

As hypothesized, intervention participants had significantly improved their LS utilization in terms of LSSc, TAFR, and MaxZ at posttest as compared to controls. Although the only comparable previous study had not used the same LS parameters as in our study, our results support the finding of improved LS outcomes in NH residents (Grönstedt et al., 2013). However, unlike in our study, LS was not the study subject of Grönstedt et al. Moreover, they had used a subjective, questionnaire-based proxy assessment, making their results only comparable to a limited extent with our findings based on objective, sensor-derived LS parameters representing objective spatiotemporal behavior.

In the PA-IG, LS trajectories showed that LS deterioration may not only be delayed but even reversed in NH residents, whereas LS parameters in the Nat-CG decreased over time as expected. Unlike Nat-CG, PA-IG participants changed their movement behavior within the facility in that they, on average, lingered further away from their room (as indicated by LSSc), spent more time in public areas, i.e., away from their private room (as indicated by TAFR), and expanded their overall LS by moving further away from their private room (as indicated by MaxZ). This may have important practical implications for quality of life of NH residents. Those with expanded LS may have better access to valuable activities, objects, or other goals, and may have more possibilities for self-chosen actions in their daily life overall (Tinetti & Ginter, 1990). Expanded LS may also come with higher potential for social interaction in more distant areas of the facility (Friedman, 1966), which may

counteract social isolation and associated negative effects such as depression (Calkins, 2001; Meeks & Depp, 2003).

On the other hand, there may be a critical threshold of the desirable amount of time residents spend in public areas (i.e., TAFR) or maximum LS (i.e., MaxZ). Especially in subjects with low motor and/or cognitive function, utilization of a larger LS may exceed residents' competence level and thus new risks (e.g., falls, going astray) may arise. Future research should therefore consider determining individual needs and wishes with respect to LS use as well as functional and cognitive reserve to gain control over an expanded LS.

Reasons for Change in LS Parameters

It is unclear whether intervention effects on LS utilization are attributable to gains in motor function, psychosocial and motivational factors (e.g., enhanced self-efficacy due to training), or both. Given that the institutional environment and its routines are strongly associated with behavior in general (Calkins, 2009) and LS in particular (Jansen et al., 2017), our intervention program may have reduced residents' environmental docility (Lawton & Simon, 1968) and promoted their environmental proactivity, e.g., their autonomy and ability to overcome environmental barriers. In the only comparable study in terms of intervention and setting, the association of changes in LS and other intervention-related effects had not been analyzed (Grönstedt et al., 2013). In our study, post-hoc examination of the impact of motor performance on LS parameters showed that changes in LS parameter were not associated with changes in motor performance over time or inter-individual differences at pretest. Possibly, the intervention led to changes in LS through other channels than motor performance, e.g., psychosocial factors. For example, we found that the intervention had a significant beneficial effect on depression (Diegelmann et al., 2017), which implies a mutual influence between depression and LS. Other factors which may have added to this effect could be additional social interaction and attention from research staff, newly established social contacts between PA-IG participants, and more frequent occasions for pleasant and emotionally meaningful encounters (Arnetz & Theorell, 1983; Calkins, 2001). However, no assessments of such factors are available in our study and thus require confirmation.

Sustainability of the Intervention Implementation

Another goal of the LTCMo project was the sustainable implementation of the program in order to prevent an expected backdrop of residents into 'old routines' on completion of the study. Hence, the intervention was implemented into routine practice after posttest measurements had been completed. Results from three-month follow-up showed that intervention effects were sustained in MaxZ and—in trend—in LSSc. This indicates that the implementation was at least partially successful. Most importantly, implementation was achieved without creating additional workload in NH facilities as the program replaced previously used activity programs. However, results showed that MaxZ trajectories differed in both study facilities at follow-up in that residents from NH2 had profited more sustainably from the intervention than those from NH1. This underlines the important role that institutions and staff have when translating research into practice in this setting. One explanation may be that in NH2 an immediate hand-over of the program was facilitated by coincidental employment of additional activity-coordinating personnel directly involved in the program's subsequent implementation into the NH's routines. This was not the case in NH1, which is why it took several weeks longer to successfully establish the program there.

Limitations

In accordance with InnovAge's overarching study objective to implement a *social innovation* with high applicability and transferability within its social context, we decided in LTCMo to examine the intervention effects and the program implementation under natural conditions with high ecological validity, thus losing internal validity due to missing randomization and strict assignment of residents to study groups. To at least partially account for this loss in the internal validity of our study, we controlled for all apparent pre-intervention differences between groups in post-hoc manner statistically. Moreover, it might be noted that the longitudinal mixed modeling approach itself also provides such control. In addition, the GLMM approach addressed the expected issue of missing data due to residents' inability to perform certain assessments or death, as it considers all available data points, including those available of residents with intermittent or permanent drop-out. In this way we increased the power to detect a meaningful effect.

Conclusions

This study is to the best of our knowledge the first to present beneficial effects of a multi-component, individually tailored PA intervention on LS utilization as assessed by an objective, sensor-based system in NH residents. Enhancing LS utilization may come with more opportunities for pleasant and emotionally meaningful encounters with others as well as more options for action in general and PA in particular in daily life. However, whether an expansion of LS is indeed accompanied by an increase of such social participation and PA needs further empirical analysis. The fact that positive effects on LS utilization were partially sustained at follow-up shows the program's high potential for successful implementation into daily NH practice.

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Table 1. Pretest Characteristics of Study Sample (n=103)

Variable	PA-IG				Nat-CG					
	n	M	*SD*	CP	*n*	*M*	*SD*	CP	Range	*p*
Age [years]	*74*	*83.6*	*9.6*		*29*	*81.9*	*11.2*		*52.9–100.4*	*.922*
Female/ Male	*74*			*.72 / 28*	*29*			*.66 / .34*		*.922*
Home1/ 2	*74*			*.50 / .50*	*29*			*.72 / .28*		*.409*
Not/ Living on Dementia Unit	*74*			*.78 / .22*	*29*			*.93 / .07*		*.578*
Length-of-Stay [years]	*74*	*2.4*	*1.7*		*29*	*2.8*	*1.9*		*0.1–9.2*	*.904*
Alive/ Death-Related Dropout	*74*			*.91 / .09*	*29*			*.86 / .14*		*.922*
Gait Speed [10-m/s]	*61*	*0.9*	*0.4*		*6*	*1.0*	*0.4*		*0.2–2.0*	*.911*
Cognitive Status [MMSE]	*70*	*18.1*	*8.3*		*22*	*20.1*	*7.1*		*0.0–30.0*	*.907*
Physical Performance [SPPB]	*58*	*6.0*	*3.1*		*8*	*5.8*	*3.5*		*0.0–12.0*	*.922*
Depression [GDS-12R]	*67*	*2.7*	*2.9*		*20*	*3.5*	*3.4*		*0.0–11.0*	*.911*
Apathy [AES-D]	*74*	*15.4*	*7.2*		*27*	*17.3*	*7.7*		*1.0–30.0*	*.904*
Concerns About Falling [FES-I]	*64*	*11.0*	*4.9*		*18*	*11.8*	*5.1*		*7.0–27.0*	*.922*
Immobile/Mobile	*74*			*.09 / 91*	*29*			*.21 / .79*		*.836*
LSSc	*74*	*1.74*	*0.4*		*29*	*1.57*	*0.4*		*1.0–3.1*	*.345*
TAFR [hours]	*74*	*5.0*	*2.2*		*29*	*4.1*	*2.8*		*0.0–8.0*	*.572*
MaxZ	*74*	*2.9*	*0.7*		*29*	*2.4*	*0.8*		*1.0–4.0*	*.032*

Note. All variables are displayed for pretest; bootstrap step-down-corrected *p*-values for interval-scaled variables from *t*-tests and for dichotomous variables from Fisher's exact tests; significant *p*-values in bold. AES-D = Apathy Evaluation Scale; CP = category probabilities; FES-I = Falls Efficacy Scale International; GDS-12R = Geriatric Depression Scale-Residential; LSSc = life-space score;

M = mean; MaxZ = maximal zone visited; n = sample size; MMSE = Mini-Mental State Examination; Nat-CG = naturally occurring control group; PA-IG = physical activity intervention group; SD = standard deviation; SPPB = Short Physical Performance Battery; TAFR = time spent away from the private room;

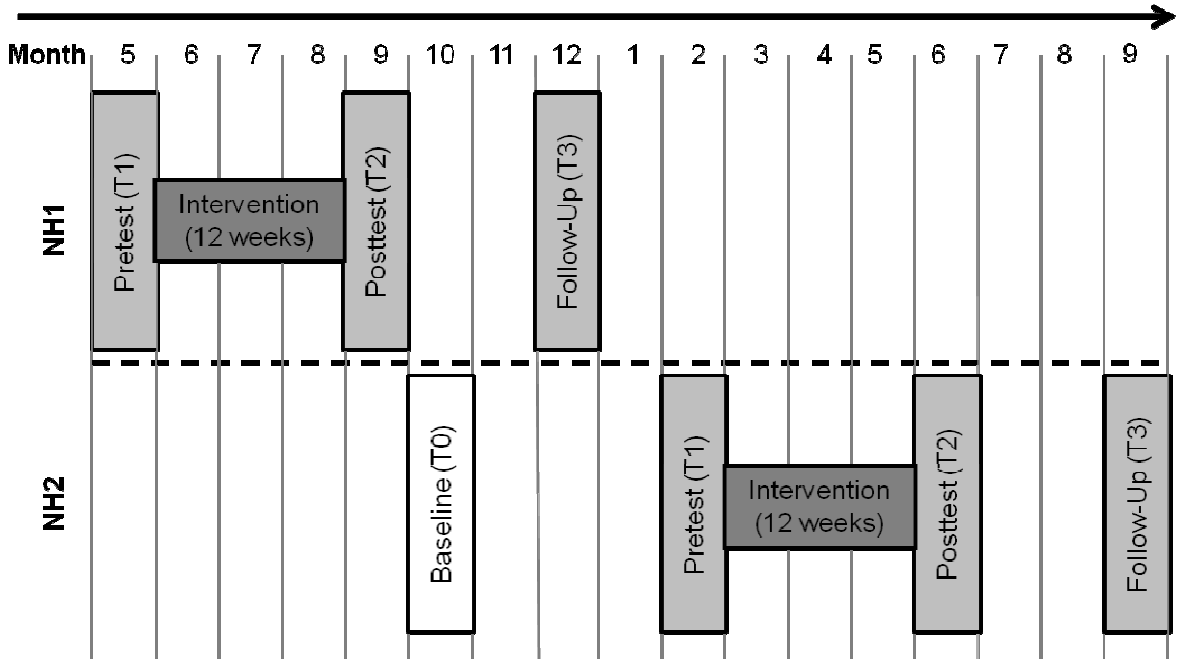
Table 2. Generalized Linear Mixed Model of Life-Space Regressed on Time-in-Study, Home, Drop-In, and the Interaction Home × Follow-Up

Parameter	*LSSc*	*TAFR*	*MaxZ*	
Fixed Effects β (SE)				
Intercept β_0	1.72 (0.04)***	*0.24* (0.12)*	2.85	(0.08)***
Time-in-Study β_1	-0.02 (0.01)**	*-0.02* (0.02)	-0.04	(0.02)*
Home β_2	0.05 (0.06)	*0.45* (0.18)*	0.02	(0.11)
Post-Intervention β_3	0.13 (0.04)**	*0.28* (0.12)*	0.29	(0.10)**
Follow-Up β_4	0.11 (0.06)$^{+}$	*0.15* (0.16)	0.39	(0.15)*
Home×Follow-Up β_5			-0.35	(0.17)*
Drop-In β_6	0.17 (0.10)$^{+}$	*0.33* (0.31)	0.47	(0.18)**
Random Variances (SE)				
Intercept	0.10 (0.02)***	*0.78* (0.15)***	0.25	(0.07)***
Covariance	0.01 (0.00)**	*0.00* (0.01)	-0.01	(0.01)
Time-in-Study	0.00 (0.00)***	*0.00* (0.00)$^{+}$	0.00	(0.00)
Residual	0.04 (0.00)***	*14.75* (1.88)***	0.31	(0.04)***

Note. n = 143 with 368 observations; *Intercept* refers to the initial value of LS parameters of all subjects included; *Time-in-Study* displays the linear trajectory of LS values per month for Nat-CG; *Home* refers to the NH related differences of LS trajectories between participants in both homes; *Post-Intervention* shows the difference between both groups at posttest (= intervention effect); *Follow-up* refers to the difference between both groups at follow-up (= sustainability of intervention effects); *Home×Follow-Up interaction refers to the different intervention effect at follow-up in both homes (only included if significant); Drop-In refers to the difference between drop-ins and non-drop-ins. SE = standard error.*

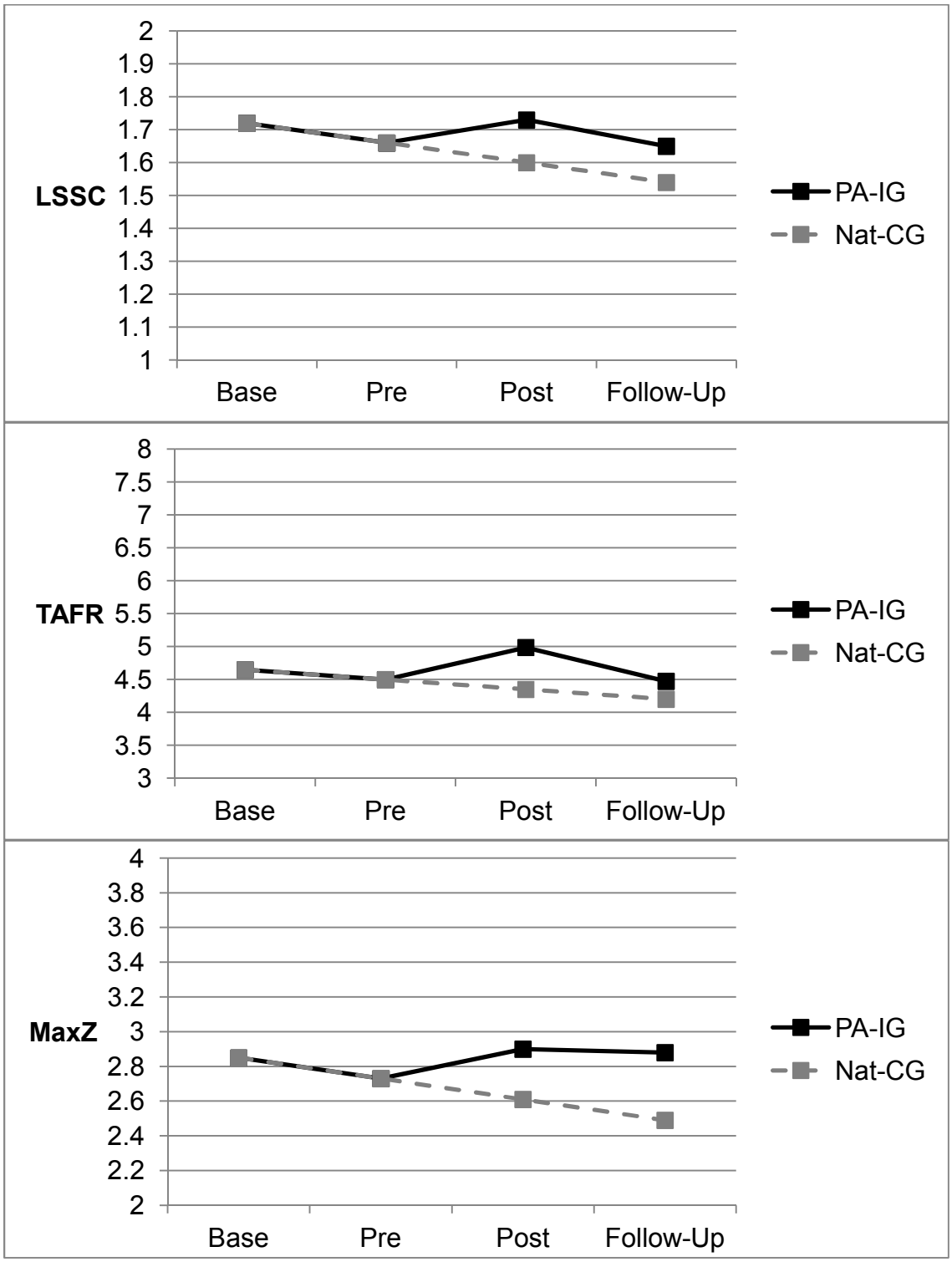
$^{+}p < .1$, $^{*}p < .05$, $^{**}p < .01$, $^{***}p < .001$, *β = fixed effects (regression weights)*

Figure 1: Study Design



Note. In NH2, participants were also assessed at baseline (T0) to document the natural trajectories of all outcomes.

Figure 2: Schematic Trajectories of LS Parameters Across All Measurement Occasions



Note. Schematic LS trajectories are presented separately for PA-IG (black lines) and Nat-CG (grey lines). Due to parallel trajectories in NH1 and NH2, figures are based on trajectories of NH2, including the waiting-control condition which had not been applied in NH1.

Manuskript V

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innovAge SOCIAL INNOVATIONS PROMOTING ACTIVE AND HEALTHY AGEING

UNIVERSITÄT HEIDELBERG ZUKUNFT SEIT 1386

Long-Term Care in Motion (*LTCMo*)

A Guidebook

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Dr. Katrin Claßen has worked as a research assistant at the Department of Psychological Ageing Research at the Institute of Psychology at Heidelberg University, Germany. She received a Diploma in psychology (2007) as well as a doctorate degree (2012) at the Heidelberg University. Her research activities include the understanding of the influence of psychological factors regarding technology acceptance in old age as well as the impact of the introduction and use of assistive technologies in in-patient and out-patient settings. She received the Südwestmetall Award and the Cäcilia-Schwarz Award for Innovations in Elderly Care of the German Association for Public and Private Welfare e. V. in 2013. In March 2015, she completed an advanced vocational training in cognitive behavioral therapy at Heidelberg University and is currently working as a therapist.

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CT:	Competence Training
HLE:	Healthy Life Expectancy
LTCMo:	Long-Term Care in Motion
NH:	Nursing Home
NHR:	Nursing Home Resident(s)
PA:	Physical Activity
QA:	Quality Assessment

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ANNEX

Structure of this Guidebook

The main goal of this guidebook is to provide information on the intervention program and the implementation procedure of the Long-Term Care in Motion (LTCMo) Project, with the intention to make the replication of this program as easy as possible. In the beginning, we provide a short background on the importance of physical activity (PA) promotion in the nursing home (NH) ecology. This is followed by a comprehensive outline of the main goals of the program and a description of useful principles that can be employed when planning and preparing a project in institutional long-term care settings. This part especially deals with implementation issues and gives useful suggestions in this regard.

As a central part of this guidebook, the intervention components that were deployed in LTCMo are explained and described in detail, with a clear focus on practical issues of the program.

In the Annex, we provide an exercise catalogue with an exemplary compilation of useful exercises and fundamental didactical principles, supplemented by a description and explanation of safety measures and safeguarding positions. Moreover, we provide tools that can be used to evaluate already existing activity programs in the nursing home setting and to assign participants to the appropriate exercise training.

In general, this guidebook is addressed at nursing home personnel, i.e. directors or care managers, social care personnel, activity coordinators, nurses and therapists or any other professions who are involved in activities with nursing home residents (NHR) and who are interested in implementing this program. It may also be of interest to organizations (e.g., senior organizations) engaged in improving the lives of older people. That said, those being involved in policy issues related to aging may also find helpful information.

Finally, we hope that the guidebook may also stimulate new PA related intervention research in the context of NH settings and we are highly interested in interactions with professionals or research groups who plan to replicate this program.

Theoretical and Empirical Background

Although home care is the predominant care setting in Europe (Rodrigues et al., 2012), the number of dependent older persons living in long-term care institutions such as NHs is expected to remain high in Europe (European Commission [Directorate-General for Economic and Financial Affairs and Economic Policy Committee (Ageing Working Group)] 2009). Due to the often discussed demographic change, the number of older people in need of help has been rising in the past decade. As is well-known, the majority of the current NH population is beyond the age of 80 years and characterized by high rates of multi-morbidity, frailty, mobility impairment, severe cognitive deficits, behavioral disturbances and depression. In terms of day-to-day behavior, an essential feature of NHR is their very low PA, compared to community-dwelling older adults in advanced old age. Such lack of PA is to be seen as an important marker of physical impairment. At the same time, an increase in PA represents an essential pathway to improve quality of life and to enhance cognitive and social functioning of old and very old individuals. That said empirical evidence supports rather large positive effects of PA on a range of important endpoints such as cardio-vascular fitness, gait and balance, fall reduction, cognitive function, and well-being in the general older population (Potter et al., 2011). PA training has also revealed sizable positive effects in terms of physical and functional ability related endpoints in those with dementia-related disorders (Hauer et al., 2006), if efficiently tailored in its application format to the remaining competencies of this specific group. There is also evidence that PA training can unfold positive effects in NHR, such as improved physical function and increased social involvement (Horn et al., 2012). Aside from positive outcomes for NHR, fostering a physically active lifestyle in the institution may go along with benefits for the institution (e.g., a more active social life and an enhanced portfolio of activities for residents that can be seen as an incentive that might also serve to increase the NH's reputation). By now, numerous exercise programs have been developed for NHR and similar populations. A comprehensive overview is provided by Horn et al. (2012), in which authors distinguish between recommendable and not recommendable programs.

In the existing research, PA has mainly been addressed as a means to improve physical function rather than as primary outcome by itself (see our systematic review by Jansen et al., 2015). In addition to making interventional use of the PA pathway as

means for prevention and enhancement of quality of life of NHR, we are aiming to go one step further by enhancing PA itself. In this way, NHR may in the long run benefit even more from an intervention that not only enhances PA due to its mere implementation, but also from a change in PA behavior due to newly established competencies. However, there are not only individual factors that determine PA behavior. It is also determined by the environment and institutional realities, which in case of NHR include NH staff, predetermined daily schedules and restrictive architectural aspects, among others. With this in mind, solely concentrating on the individual level seems short-sighted, as activity behavior is not only based on individual barriers or motivators. Until now the number of more specific and at the same time comprehensive intervention approaches taking into account these characteristics of this specific population is very little. Herein we present a multi-component intervention approach that is based on individually tailored physical exercise training for NHR combined with motivational competence training for staff. It was implemented within the course of the project "Long-Term Care in Motion" (LTCMo) in two NHs in Heidelberg, Germany. LTCMo is a subproject of the interdisciplinary research project "INNOVAGE – Social Innovations Promoting Active and Healthy Ageing" (Health-F3-2012-306058[1]) funded by the European Commission's Seventh Framework Program.

The primary aim of LTCMo is to present a social innovation with the potential to promote PA among NHR in order to prevent a further decline or even elicit an improvement in motor and cognitive function, and thereby improve the living conditions and quality of life in NHR in line with the main concept of INNOVAGE (*active and healthy ageing*). However, the mission of INNOVAGE is not only to create a social innovation, but also to spread the newly created and proven concepts. This guidebook was developed with the intention to address relevant stakeholders and users. It highlights the potential of PA as well as its barriers, which can hinder a successful implementation of the intervention program, but also strategies to overcome them. Furthermore, we provide a detailed description of the multidimensional training program to make an implementation as easy as possible.

The guidebook is based on previous research findings and experiences made during the implementation of the intervention program. For further information on the

[1] http://www.innovage.group.shef.ac.uk/

scientific background and empirical outcomes of the project, please see our already published works:

- *Systematic Review* summarizing previous findings regarding interventions and their effect on PA in NH settings: Jansen, Claßen, Wahl, & Hauer, 2015
- *Study Protocol* describing the research design and methodological aspects of the LTCMo project: Jansen, Claßen, Hauer, Diegelmann, & Wahl, 2014. Additional scientific papers are planned and will be published during the final phase and in the aftermath.
- A number of manuscripts describing the project and outcomes are currently in preparation and will be published soon.

Main Goals of LTCMo

The aim of LTCMo was to develop, empirically evaluate and disseminate a socially innovative and sustainable intervention in the NH ecology by means of a multidimensional intervention program (resident and staff oriented) with the potential to promote PA behavior in NHR. It is very important to note that unlike in most other intervention driven studies and programs in long-term care LTCMo addresses physical activity decidedly in terms of behavior.

Looking at the institution 'nursing home' as a 'natural lab', the approach was sought to address this 'natural lab' from several different angles that would add up to achieving this overall goal of enhancing nursing home residents' physically active behavior. In particular, a controlled intervention was to be exerted at two levels of long-term care institutions: on the side of the main end-users, the nursing home residents, and on the side of nursing home staff. In order to modify physically active behavior, multiple factors such as health and psycho-social status, motor and cognitive function as well as motivational resources that have to be considered due to their large effects on physically active behavior. The decision to exert an exercise-based intervention approach in combination with competence training for staff members was based on several leading considerations.

First, the program can be implemented in a controlled group environment, which not only fosters motor function and skills but also contains social aspects, helping to establish close social contacts in-between participants and between participants and group supervisors. Through close contact to all participants, supervisors are able to

not only improve motor function by means of exercise, but to also activate motivational and psycho-social resources of participants that are important determinants of activity behavior. For example through the improvement or even recovery of the most important key motor functions (sit-to-stand transfer, standing, walking), self-efficacy and a feeling of self-determination may be enhanced, resulting in more active behavior. In addition, constant groups in 'safe' surroundings help achieving high adherence rates, especially if tailored to end-user needs.

Secondly, the group approach allows including a broad range of participants when it comes to motor and cognitive abilities. These can be assorted into homogenous groups, which helps to prevent under- or overexertion of residents and to keep motivation on a high level.

Thirdly, by motivating residents to be more physically active, staff is able to enable residents to use their potential and their competencies optimally. Based on own observations, the main potential of this approach lies in the recurrent close bonds between nursing staff and nursing home residents. Nursing staff is expected to have strong influence on residents' behavior. Therefore, changing staff members' interactional behavior with residents is hoped to increase the awareness of residents' health and motion behavior, self-efficacy, control beliefs, self-regulation, and autonomy, as empirical evidence name these as crucial factors for being physically active.

Fourthly, through offering a virtual, game-based exercise training ('serious game') targeted at motor-cognitive tasks, residents who are not appealed by "standard" exercise forms are addressed.

A unique feature of the approach was that the explicitly end-user oriented approach came at the same time, at the research and methodology level, with an extensive and innovative technical assessment of physical activity, life-space and motor performance as well as subjective interview- and proxy-based questionnaires on psycho-social outcomes were completed (study protocol by Jansen et al., 2014). To our knowledge, this represented the first combination of a cutting-edge research methodology and a resident- as well as staff-oriented intervention approach in a long-term care setting.

Setting the Stage

The implementation of social innovations and programs such as LTCMo is challenged by a series of barriers, particularly in the NH context. NHs represent highly structured institutions with a large number of well-established routines and practical constraints, which are often not obvious for an external person. Such constraints and routines may follow a rationale which may deviate or even contradict research interests or implementation of programs. Actors in such an institution, e.g., residents, staff or management, also may have diverging interests. As the success of a project such as LTCMo heavily depends on acceptance by institutional members, setting specific routines and interests will have to be taken into account. Acceptance and support are not granted and will have to be merited. As a general recommendation, respect for the setting and actors should be mandatory. In case of scientific studies, team members may therefore rather behave as guests—and not as intruders—in any given situation. Time and resources invested for those issues may pay off when the project is implemented. The following implementation principles might facilitate the acceptance of the main actors and the intended intervention program in a NH setting. Some of the principles are of general importance; some are specific recommendations for scientific staff or other external personnel.

→ Principle I: Inform the whole system in consideration of the hierarchical structures (top-down-regulated approach)

Detailed information on the planned activities and a continuous update is an important prerequisite of any project. The information process may not only be used for delivering news but also to get in contact with the persons in the institution. As within the formal hierarchy of an institution, information processes, targets and types of deliverance should be tailored to the addressees. Leading management, staff, relatives, legal representatives and residents represent different target groups requesting different ways of communication. Regarding all target groups, essential factors for motivation are the valuation of individual opinions, the clarification of the project aims and the positive impact on resident and staff level as well as a skilled way to establish the first contact.

Step 1: Leading management

As a first step, the leading management should be informed about the project to achieve a supportive relationship and a formal “go”. Major target of this step is to clarify concerns and convince the management of the importance of being physically active in a NH and the positive effects which can be achieved even in such a vulnerable population. As with other target groups, it is always helpful to take the perspective of professionals in institutions as a starting point. Major pros may be represented by quality management or advertising/publicity/sales promotion issues. Cons may touch concerns about use of additional (labor-) resources and the acceptance of residents and staff. Information should be delivered step by step using different approaches. Formal and less formal talks accompanied by a clear study description will help to get support. Hierarchies with the management will have to be respected with the leading persons to be informed first. The support of the leading persons and their willingness to cooperate is crucial for any further steps.

Step 2: Staff team

Once the management promotes the project, staff should be informed and involved as their support of the program is essential for its successful implementation. However, convincing the staff team that the intervention program is worth implementing can be challenging due to specific workplace characteristics (e.g., lack of time, inconvenient shift times, heavy workload and the need for emotional labor) and a series of doubts regarding the effort and the impact of the program.

Firstly, a lack of specific knowledge and insecurity on how to support PA related behavior represent crucial limitations for the implementation of such innovative models. Due to functional, physical or cognitive losses in NHR, staff may doubt that a considerable increase in residents’ PA is possible and feasible in principal terms without taking too many risks. As a typical consequence, a dependency-supportive interaction style with residents that again strengthens residents’ sedentary behavior has been reported in previous NH related literature (Baltes & Wahl, 1992). Due to the key role of NH staff to trigger or hinder activity-related behavior, LTCMo aims to convince and enable staff members to use specific ways of communication and PA-supportive behavior.

Secondly, some staff members may have concerns about additional workload and may fear critical evaluation of their individual work. Most colleagues working in the

institution will not have any training or insight in scientific or implementation work, which may mystify or devaluate project proceedings. Furthermore, there might be skepticism against external persons who do not work in the same institution and take a more theoretical perspective. Comprehensive information about project plans, limitations, and goals may help to set straight critical considerations. Referencing the complete restriction to forward any information concerning residents and staff to management or the public as requested by ethical boards for project proceedings will help to clear out concerns related to employment law or ethical issues. It may also be helpful to address the potential positive consequences of the project on staff level, including everyday issues such as less care support for residents in case of a successful improvement in motor key functions as targeted in the project. Because of the overwhelming impact of persons working in the institution and their close contact to the target group, staff training is a major intervention approach in this training concept. Daily shift changes or other personnel gatherings may be an adequate organizational opportunity to inform staff. At a given and suitable time, a formal general information meeting including staff and management should also be held. To establish a more personal, informal access it may prove sensible to be present at the site for a longer period of time and to be available for less formal requests. It may be even possible to establish a familiar relationship with staff as well as residents. A promising way to reach a solid relationship is to play an active part in the daily care work, e.g., by doing a short-term internship. An added value is to get to know the daily routine of staff and residents as well.

Step 3: Residents and their relatives

It proved sensible to address residents as potential participants personally in a motivating and emphatic manner to take care of their specific questions, needs, and preferences. It is also advisable to inform relatives or legal representatives about the program and its purposes.

→ Principle II: Learn about and evaluate existing activities within the institution

Before implementing the intervention components described in this guidebook, the setting should be prepared and analyzed carefully and thoroughly. In each facility, some forms of activity groups, therapy classes or any other programs, circles, etc. are already installed. Some of them may be very useful or even very close in scope and execution to what is presented herein. So before modifying the weekly schedule,

all activities, be it single or group activities, should be analyzed and checked for usefulness and their potential to be modified according to the LTCMo components. A systematic evaluation should include quantitative (e.g., frequency, duration, weekday, time of day, number of instructors and participants, sequence) and qualitative (e.g., concept, content, aim, adaption to target group, instructors' qualification) criteria. Activities that are similar to the intervention that is planned to be installed may either be cancelled during study course or used as expansion of the intervention if the personnel situation allows parallel activities.

A major problem for scientific or any other external projects in real life institutions is that the institutions have established roles and routines, which may be interrupted or altered by the project. The sustainability of successful project standards might be endangered when a project ends and study resources as well as well-trained study personnel are no longer available. To develop a sustainable intervention strategy tailored to the institutional setting and its residents, it is therefore mandatory to start with a description and evaluation of the existing activities in such a highly structured environment (see ***Annex***). Four major considerations will lead the process:

Respect established and successful structures and work of staff

It has to be kept in mind that external projects have their own conditions and aims, which may not be identical with institutional requests. It is a simple fact that studies are limited in time in which project activities interfere with the daily routine of the institution. A first important step is to explore specific NH routines like everyday care, meal and activity schedules. A short-term internship for external project collaborators (as mentioned above) may offer comprehensive insight and help to get involved. Many of the established structures have their history and have been developed for good reason. A useful routine, interrupted by a study project, may only be restored with substantial effort. Modifications of established processes and activities may lead to a negative personal feeling (e.g., to be insufficient) or the anticipation of additional workload and stress by institutional activity coordinators. Resistance is expectable when the need for any change is not clear or information about the frame conditions is insufficiently communicated. The critical assessment of proceedings in non-scientific settings requires evaluation of the organizational (objective workplace characteristics, daily routines and existing programs) as well as the individual

(perceived job demands and resident-staff-interaction, work-related attitudes) situation within the institution.

Learn about the background of existing activities

Established activities within institutional settings have their own history and conditions, which may not be obvious at first from an external or scientific point of view. Partly those activities are triggered by strictly content-related criteria (e.g. improvement of quality of life or activity promotion). Partly also formal criteria (such as quality assessment; QA), a lack or abundance of space/equipment/media, as well as education and training or individual preferences of staff and residents who participate determine the activities. For a successful implementation of project standards it is useful to consider all those different perspectives and address those which may support study targets or sustainability of project standards when the project runs out. The residents' perspective might be extremely helpful in getting an impression of preferences, needs and routines of the main target population of the project.

Evaluate activities with respect to the project aims

Due to the highly structured character of the NH environment, there is only limited space for additional activities as planned in study projects or activation programs. In order to prevent overload or distress of residents and staff, it is necessary to identify optimal periods for project sessions and avoid overlap of programs. Therefore, existing activities should be systematically evaluated using quantitative (e.g., frequency, duration, weekday, time of day, number of instructors and participants, sequence) and qualitative (e.g., concept, content, aim, adaption to target group, instructors' qualification) criteria. Activities that are similar to the intervention that is planned to be installed may either be cancelled during the implementation or used as expansion of the intervention if the personnel situation allows parallel activities.

Try to integrate project standards in established activities and identify active protagonists

The systematic summary of existing activities will help to integrate project standards into the established system. In case of external projects, it can be used to identify eligible persons who may be interested and willing to implement and sustain the

project activities. In this case, responsible institution members might be integrated at an early stage and successively incorporated under regular supervision of the program leaders (expertise of psychologists, sports scientists or other specialists) to ensure sustainability of training components. The supervision should be kept up until the end of the project to reach an appropriate continuation and ensure sustainability of the program. At this stage, a guidebook including training components and a detailed description of exercises is very helpful in facilitating training implementation through nursing home staff. The management of the institution should be integrated into this process in order to encourage committed staff to become active protagonists of ongoing activities. It might be helpful to use the management perspective to balance requested additional resources for such implementation with added value for institutions (e.g. marketing/ QA).

Evaluation and Sustainability of LTCMo

In case of external projects, a long-term implementation of the program should be envisaged, so that participants can profit from the intervention during the project and also beyond. In LTCMo, an important issue was the sustainable implementation of the program into daily NH routine. Several steps were taken to achieve this goal. During the intervention phase of the study, social care assistants who worked in the NHs took part in the exercise groups and the individual trainings on a regular basis. In this way they were able to learn about the main principles of the program, to learn basics on group leadership and instruction, to gain basic knowledge of exercise science, and to develop an adequate repertoire of exercises. In both facilities, management and staff were convinced of the positive effects and the additional value of the program. After the end of the intervention phase, the program was seamlessly continued by these staff members, under regular assistance and supervision of LTCMo staff until they were able to conduct the program in an appropriate and effective way without needing support. In both NH facilities, this required a rearrangement of the weekly activity schedule which was only taken into consideration due to the likewise extraordinary resonance of NHR, nursing staff and NH management. As a consequence, both NHs that participated in the study implemented the exercise program into their care and activity routine. Several groups are taking place twice weekly with up to eight residents in each group. In one of the

NHs, the staff training became an inherent part of the internal training schedule. Unfortunately, the competence training was not completed in the second NH. Reasons for that may be that in this NH, LTCMo staff was not able to establish a more personal relationship to nursing staff, e.g. by doing a short-term internship on care level (as described above). In both facilities, research staff of LTCMo is still providing regular support in the execution of the program when necessary.

As part of sustainability measures, it is an important aim for LTCMo to make our approach accessible and also reproducible for institutions and nursing home personnel. Therefore, the physical exercise training and the CT training courses for NH staff will be offered as a two-day training course via AGAPLESION Academy, a well-established care and health educational institution in Heidelberg with nation-wide outreach, to allow the implementation of LTCMo into the care routine of interested nursing homes.

Although our study has faced several methodological challenges (e.g., rather small sample size; non-randomized controlled trial), we believe that our approach has the potential to contribute to the enhancement of NHR's quality of life and at the same time stimulate further PA-related research with vulnerable populations at large.

The data analysis is currently underway - preliminary evidence already shows that positive effects on motor performance and physically active behavior were achieved.

Intervention Approach

The program LTCMo has been conceptualized for use within long-term care institutions. The physical exercise training is targeted at residents of such institutions; the competence training has been developed for nursing and social assistance staff. In general, all residents and staff members can participate in the program, irrespective of cognitive and motor impairment. Specific requirements and exclusion criteria are delineated below. The key components of the program are illustrated in Figure 1. Residents receive either physical training in homogeneous exercise groups or in an individual one-to-one training form if group assignment is not possible due to sever motor impairment or distinct behavioral problems. For residents who are interested in new forms of exercise, or residents who are not appealed by "standard" exercise forms, a serious games training can be implemented in the NH. Each of the training approaches is described in detail below.

On staff side, a competence training aiming to support physically active behavior of residents is implemented. It consists of theoretical input as well as practical exercises. It also provides a platform to discuss particular cases.

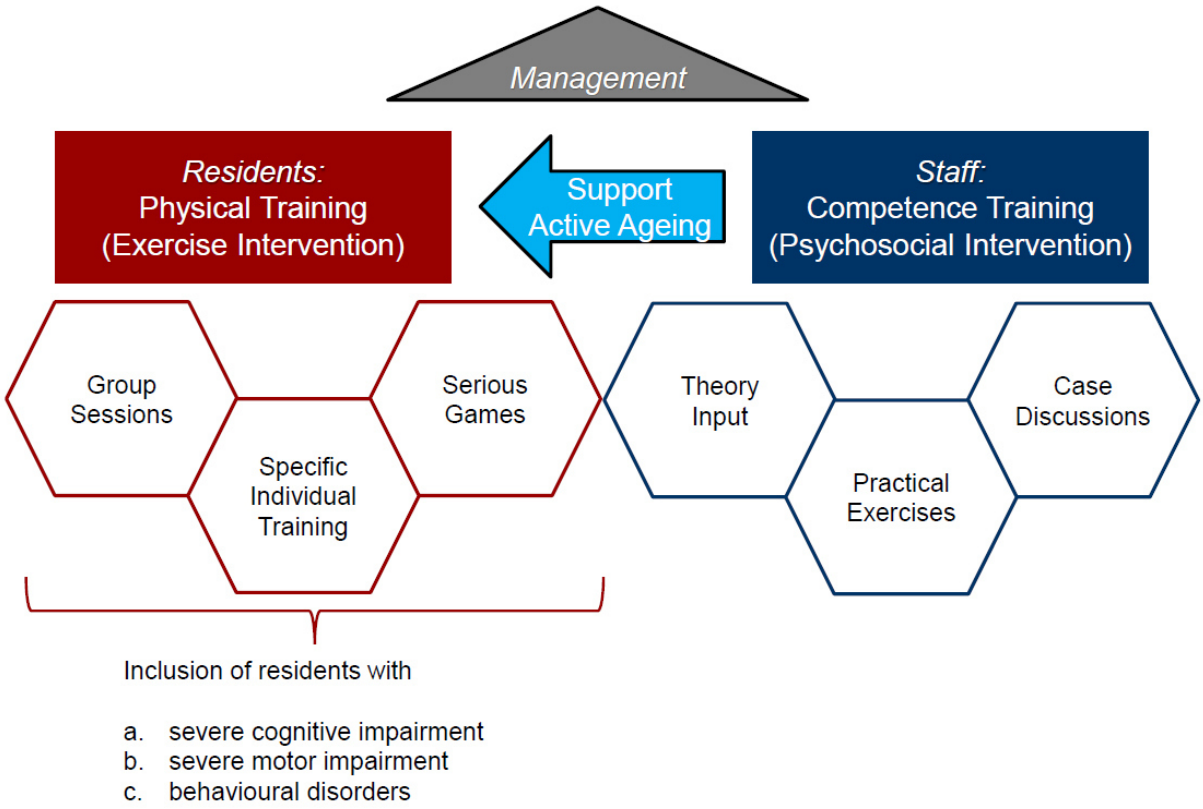


Figure 1. Illustration of the intervention components.

The Exercise Approach for Residents

The physical training relies on the existing evidence of successful PA intervention in multi-morbid, frail, older persons with and without cognitive impairment (Hauer et al., 2001; Hauer et al., 2012; Schwenk, Zieschang, Oster, & Hauer, 2010) and is at the same time specifically tailored to the needs of the target population of physically and cognitively impaired NHRs. Thus, its bottom line is a rigorous focus on functional and strength exercises and the improvement of key motor qualifications balance, walking and sit-to-stand transfers that are necessary for mobility, autonomy and motion security. Additionally, the intervention pursues the goal to improve psycho-social outcomes such as social participation, self-efficacy, depression, and quality of life. In addition to influencing external factors and barriers as mentioned in previous chapters of this report, training improvements in motor, psychological, and cognitive status are hypothesized to increase activity behavior as these factors have been identified to be high impact predictors of physical activity.

A major goal of the project was to include as many participants as possible, requesting a tailored approach for sub-groups with specific demands for each group. Therefore, the physical training is specifically designed for each target group of NHR, characterized by old age, advanced frailty, multi-morbidity, and motor as well as cognitive impairment and behavioral aberrations. Despite these serious restrictions and deficits, such characteristics do not preclude participation in general and individual potentials differ a lot. Therefore, the physical intervention includes multiple exercise approaches with the aim to offer a comprehensive exercise repertoire, which can be adapted to the special individual needs and limitations of residents (see Table 1). When grouping residents, motor function as well as problematic behavioral symptoms should be taken into consideration. In the ***Annex*** a classification tool that was developed for this purpose is attached. We defined three different approaches regarding the group exercise training; each with different group allocation criteria.

The first **group training** approach was intended for ambulatory participants with advanced motor function, in which exercises show higher intensity and complexity due to advanced physical and cognitive function of the participants. A second approach was implemented for residents who at least were able to stand and showed only mild to moderate cognitive impairment without serious behavioral symptoms.

For residents with severe cognitive impairment in combination with behavioral symptoms of dementia a third exercise group training was installed, as successfully shown in code-secured living units in LTCMo. This sub-division of training approaches allows for the inclusion of as many residents as possible.

However, severe cognitive and motor impairment represents an exclusion criterion for the **serious games** approach, as successful participation requires the motor ability to complete stepping tasks without support as well as cognitive functioning in terms of task-performance based on visual stimuli and thus may lead to frustration in case of overexertion.

Residents with advanced postural deficits / motor impairment or severe behavioral problems due to cognitive impairment are not included in exercise group sessions but eligible for **specific, individually tailored training**, which is based on exercises used in the group training and adapted to the individual abilities of the participants in an individualized, one-to-one training situation. Residents with aggression-related behavior problems were excluded from participation.

Table 1 gives an overview of the different exercise approach components.

Table 1. Physical Exercise Training Approaches

Training approach	Group Description	Frequency	Group size
Supervised group training I	Residents need to be able to communicate verbally, to walk with or without support, and to have no behavioral symptoms that impede group participation	45 minutes; twice a week	4-8 residents
Supervised group training II	Residents need to be able to communicate verbally, to stand up, and to have no behavioral symptoms that impede group participation.	45 minutes; twice a week	4-8 residents
Supervised group training III	This training is specifically for residents of code-secured living units with severe cognitive impairment, showing pronounced behavioral and psychological symptoms of dementia.	45 minutes; twice a week	4-8 residents
Specific individual training	This training is for residents with severe motor impairment or cognitive impairment in	30 minutes; twice a week	1 resident

	combination with severe behavioral problems. Participants should at least be able to stand with close supervision and support and show no highly aggressive behavior.		
Serious game	Residents without or mild cognitive impairment; able to stand and step without aid.	15 minutes playing time per participant	3-4 residents; 1 person plays at a time

Group Training

In the following, participant characteristics, aims, and training components of the three different group training approaches are described. In addition, special requirements for group trainings in code-secured living units are highlighted.

It is important to note that in LTCMo improving motor function is a means to an end - the aim is not just to improve motor function but to enable residents to be more physically active. Improving or even recovering the most important key motor functions (sit-to-stand transfer, standing, walking), self-efficacy and a feeling of self-determination may be enhanced, resulting in more active behavior .In addition, through close contact to all participants, supervisors are able to not only improve motor function by means of exercise, but to also activate motivational and psycho-social resources of participants that are important determinants of activity behavior. With this in mind, the table below refers to practical goals of the exercise groups regarding improvements in motor function.

Supervised Group Training I	
Participant Characteristics	Ability to walk without aid; to stand up independently and sit down without any support; to walk longer distances without help.
Aims	Physical activity promotion in terms of number and duration of active episodes; improvement of walking performance, dynamic postural control, and sit-to-stand/sit-to-walk transfers.
Training Components	Functional strength training: Sit-to-stand transfer training without using the arms. Dynamic balance and gait training: Different standing positions; improvement of stability and duration of standing posture; different walking exercises (e.g., narrow vs. wide distance between feet; slow

	vs. fast walking; uneven floor surfaces).
Supervised Group Training II	
Participant Characteristics	Unstable walking with aid; standing up and sitting down without personal assistance is possible.
Aims	Physical activity promotion in terms of higher frequencies of standing and enabling participants to walk short distances. Improvement of static and dynamic balance (i.e., stable standing); improvement of sit-to-stand transfer. In the further course of the training: support of stable walking, walking security, and a homogeneous walking pattern (then: transition into Group I).
Training Components	Support of stable standing without aid by exercising in different standing positions and at different levels of difficulty. Sit-to-stand training: trying to stand up and stand still; in the long run, transition to sit-to-walk training Gait training: In the beginning, improvement of gait performance with support; gait episodes without aid if this seems possible; prolongation of the duration of walking episodes under supervision and improvement of a homogeneous walking pattern.
Supervised Group Training III	
Participant Characteristics	Participants show pronounced cognitive impairment accompanied by severe behavioral problems. Participants should be ambulatory and able to stand up with little or no support. In LTCMO, this group was implemented in a code-secured living unit.
Aims	Improvement of static and dynamic balance (i.e., stable standing); improvement of sit-to-stand transfer. Support of stable walking, walking security, and a homogeneous walking pattern. In this special group, aberrant motor behavior or wandering behavior was frequently observed. Therefore, it is another aim to divert this kind of ‘unwanted’ active behavior to meaningful activities and exercising activities.
Training Components	Functional strength training: Sit-to-stand transfer training without using the arms. Dynamic balance and gait training: Different standing positions; improvement of stability and duration of standing posture; different walking exercises (e.g., narrow vs. wide distance between feet; slow vs. fast walking; uneven floor surfaces) Focus on social aspect of group training: exercising together by execution of clearly constructed and meaningful tasks.

Special Requirements	Depending on the severity of cognitive impairment, group organization may require adaptations. In LTCMo, instead of a double chair circle, residents were seated side by side in direction of a hallway which was used for exercises. Then, residents were attended to one after another from left to right. When the last participant in the line was done (right) with his round, the first in line (left) started with the next exercise. Residents were seated close to each other so that social contact and conversations were facilitated. In addition, this organization form was found to be easier to understand for the participants than the double chair circle. Code-secured living units are typically built barrier-free. This allows an "open" group setting in which participants are able to leave and come back anytime in case keeping them in the group is not possible. However, this also means that non-participating residents may enter the exercise area every now and then. Therefore, it is helpful to have additional personnel who can address these external visitors without disturbance of other participants.

Personnel Requirements: Communication and Appearance

The group exercise sessions should be led by a qualified person who is familiar with the special requirement of the population (e.g., physical therapist, sports scientist, nursing staff, social assistants or other qualified personnel) and, depending on group size, at least one assistant to provide highest possible safety for participants. During the implementation phase, staff members should also become familiar with communication strategies to ensure suitable training conditions and encourage PA-related behavior (see Table 2). This includes factors related to verbal instructions (clear instructions, loud voice, positive wording, etc.) but just as much non-verbal instructions (demonstration, tactile support, facial expression, etc.) that help the participants to understand what they are supposed to do. Especially in groups of residents with behavioral and psychological symptoms of dementia (BPSD; Finkel et al., 1996), further dementia-specific strategies are necessary to allow organization and implementation of exercise groups, e.g., measures of person-centered care (Brooker, 2004) and validation techniques (Feil, 1993), which are based on emphatic attitude, respect and appreciation of each individual without judgement. In this regard, it is very important to give particular attention to the individual as well as the group as a whole, and to create a positive social environment to enable the person with dementia to experience relative well-being while exercising.

Establishing a stable personal relationship with participants is a key element for adherence and motivation. Therefore, it is advisable not to exchange personnel during the program if possible. Personal conversations are of high importance in this context. An instructor should be able to show interest in the needs and feelings of the participants and find time for personal conversation, e.g., while bringing participants to the training room. In this way, the instructor can gather information regarding physical and mental condition, which may also be important to consider when conducting the training. Especially aspects which can be strong barriers to physically active behavior, such as apathy, depressive symptoms or a lack of self-efficacy, are easier to recognize and to address when a personal relationship is established.

Regarding his appearance, the instructor has to be able to attract attention and to act as a strong motivator with self-assurance, as participants need clear and definite instructions and motivation. Possible insecurities of instructors inevitably lead to insecurities on the side of participants. Therefore, it is most important to prepare each exercise session in advance and maintain a clear and constant structure.

Table 2. Overview of Communication Strategies and Approaches (Brooker, 2004; Feil, 1993; Oddy, 2011; Schwenk, Oster, & Hauer, 2008)

Verbal instructions

- Attract participants' attention (e.g., by calling the name) and give attention
- Speak slowly, calmly, loud and clear
- Practice active listening
- Give short and clear instructions
- Repeat your request if necessary and be patient
- Use positive wording (e.g., "Please stay seated" instead of "Don't stand up")
- Link movements with associations (e.g., 'Stand like frozen')
- If there are two or more assistants, decide who should speak
- Chose a proper position (ideally face to face)
- Signalize the simplicity of the task (e.g., "Just move to the marked line")
- Try goal-based instructions if you assume the person could possibly manage the task

Non-verbal instructions

- Demonstrate exercises ("mirroring")
- Give tactile support (e.g., for correction of movements)
- Give rhythmic support (e.g., "and back… and forth…")
- Be attentive to participants' non-verbal reactions (e.g., facial expression, body movements)
- Monitor and control your own non-verbal behavior (e.g., facial expression, tone of voice)

Person-centered approach and validation techniques

- Emphatic attitude
- Respect and appreciation of each individual
- No judgement of individual behavior
- Give particular attention to the individual but also the group as a whole
- Create a positive social environment
- Promote well-being while exercising

Organizational Aspects of the Group Training

The exercise groups should be conducted in 45-minute sessions at least twice a week in small groups of four to eight residents, ideally always in the same room to create familiar surroundings. The level of difficulty should be increased with caution. In the beginning, simple exercises should be conducted and frequently repeated in order to enable residents to perform basic motor tasks such as standing up and stepping. To further motivate participants, constant but appropriate positive feedback should be given. When basic motor functions are stable, participants can progress to advanced levels of exercise, i.e., complexity and challenge of tasks can be

increased. The complexity and intensity of exercises has to be individually adapted to the performance level and the training progress of the participants. In any case, exercises are not supposed to cause overexertion or pain. If so, the exercise has to be interrupted or reduced in intensity/duration. For participants which show overt symptoms of exertion or fatigue, the responsible physician must be consulted in advance (and during the program, in case of adverse events). It is important to keep in mind that self-report abilities may be limited in cognitive impaired people. Persons' non-verbal reactions (e.g., facial expressions, vocalization) therefore have to be observed carefully.

Figure 2. Double chair circle.

As exercise training inevitably increases risk exposure, safety aspects are of particular importance. A ratio of four participants to one supervisor or assistant should be given. In addition to the personnel itself, the compliance to certain organizational aspects (see also guidelines in Table 3) helps to ensure safety, e.g. by using a double chair circle (see Figure 2), which allows participants to hold on to a chair and sit down whenever necessary. In addition to its safety aspects, the double chair circle allows for internal differentiation, which means that each participant is able to train in a group and according to his/her individual performance level (e.g., with/without holding on to a chair) at the same time. Further information on safety measures are described in the exercise catalogue.

Special organizational aspects of group trainings in code-secured areas are delineated under 'Special Requirements' of Group III above.

Table 3. Overview of Organizational Aspects and Training Guidelines: Group Training

Organizational aspects and training guidelines
• Always use the same room for the training (ideally a familiar area) • Keep constant and simple organizational forms (e.g., same instructor; same groups) • Arrange groups as homogenous as possible with respect to motor and cognitive function • A maximum of eight participants should not be exceeded • Individual differentiation should be made possible • Training should be conducted in small groups under the supervision of at least two trained instructors • Be attentive to postural instability and risk of falls • Adapt the training to the individual status • Training equipment should guarantee highest possible safety
Training instruction
• Use simple structured exercises • Increase level of difficulty with caution • Frequently repeat exercises • Give positive feedback to reinforce motivation • Use dementia-specific communication strategies (if necessary)

Spatial and Equipment Requirements

The implementation of the physical exercise training requires an adequate room with enough space for a double-chair circle for eight residents. Usually spatial conditions are poor in NHs. Still, if some options are available, some issues should be considered.

The room should be neither too small nor too big so that participants do not feel confined or lost and it should allow a certain amount of privacy without external disruptions or interfering activity. Too many people leaving or entering the room as well as people passing by might be a distraction for participants. The interior of the room should be bright and inviting to provide a harmonic atmosphere. It is important that the room can be heated and ventilated if necessary. A very important issue is the floor coating. The floor should not be slippery or uneven. Handrails on the walls might be helpful but they are not mandatory. As the training ideally is conducted within the premises of the NH, a quick connection to nursing staff in case of emergency can be expected. To prevent longer interruptions of the training, a near bathroom is very convenient.

Further spatial requirement for groups in code-secured areas are delineated under 'Special Requirements' of Group III above.

In addition to the spatial requirements, the following materials should be available to allow for diverse and functionally effective exercise compilation (see Figure 3):

- Two stable chairs (ideally with side armrests) have to be available for each participant in order to build a double chair circle.
- Balls (e.g., exercise balls or foam balls)
- Balance pads (e.g., Airex® or Terra Sensa®)
- Porcupine balls
- Step stools
- Ropes

Figure 3. Useful materials to be used in exercise training.

Specific Individual Training

The specific individual training was developed for those residents who show distinct motor and functional impairment and/or severe behavioral problems that would result in unacceptable disturbance of group activities. The exercises are similar to those used for group training. One major pro of individual training is that the individual supervision allows perfect fit to the personal needs of an individual. Individual problems and deficits can be addressed in a more detailed manner. However, this form of training is very personnel-intensive and requires an instructor who is able to do the training without help of an assistant in a one-on-one situation.

Specific Individual Training	
Participant Characteristics	Residents show severe motor impairment and or cognitive impairment in combination with severe behavioral problems, but without aggression-related behavioral problems. Independent standing is not possible and requires constant help of at least one supervisor. Explore, whether re-learning or improving standing is possible.
Aims	Support of dynamic sitting; relearning of sit-to-stand transfer; advance to Group I.

Training Components	In the beginning main focus on seated strength and mobilization exercises: strengthening of leg muscles (leg extension) to enable sit-to-stand transfers. In the course of the training, conduct standing exercises with support if possible. For ambulatory residents who are eligible for individual training due to behavioral problems, the training components have to be adapted to the functional abilities. Based on the description of Group I and II, the training components can be adjusted to each individual.

Serious Games Approach

In general, physical training is based on repetitive and standardized training tasks, which guarantee effectiveness, but will possibly fail to attract all participants. An alternative mode to motivate persons to be physically active is a serious games approach, in which motivational aspects are driven by a game setting, and effectiveness is supported by a "serious", evidence-based exercise task. In this supervised cognitive-motor training, the motor task is based on a progressive functional task (stepping/dynamic postural control), the cognitive task targets different cognitive sub-performances such as divided attention, temporo-spatial orientation, reaction time, and executive performances (Pichierri et al., 2012; Schoene et al., 2014; Sherrington et al., 2008).

Serious Games Training	
Participant Characteristics	Participants are able to stand and step independently and are not or mildly cognitively impaired.
Aims	The game based training addresses both motor and cognitive performances. The stepping task focuses on dynamic postural control (important for motor key features such as standing or walking); the cognitive task relates to cognitive sub-performances (such as temporal-spatial orientation, executive functions).
Training Components	Supervised cognitive-motor training. Participants have to execute steps (forward, backward, right or left) on a dance plate as indicated on a computer or TV screen.

Due to the execution of major motor-cognitive tasks that are relevant for the target group, such Serious Games are expected to induce more meaningful improvements than simple virtual gaming consoles (e.g., Nintendo Wii or Sony PlayStation). Another important feature of this type of Serious Game is immediate referral to stored

previous performance and respective feedback of progress and goal achievement during ‘play’, meaning a direct motivational support. Difficulty can be individually adapted as the program depends on previous individual performance in each level to prevent overtaxing of users. The standardized program has been adjusted to the performance level of frail older adults with and without cognitive impairment in pilot testing prior to the intervention.

The Serious Game used in LTCMo was the “Dividat Step Plate”. For further information, please visit http://www.dividat.ch.

Competence Training for Staff

The main aim of the competence training is to enable staff members to use specific ways of communication in order to motivate residents to be more physically active. We aim to increase the awareness of residents' health and motion behavior, self-efficacy, control beliefs, self-regulation, and autonomy, as empirical evidence name these as crucial factors for being physically active. The resulting change in staff members' interactional behavior is hoped to enable residents to use their potential and their competencies optimally.

Theoretical and Empirical Background

The primary aim of the competence training (CT) is to implement and enhance PA-encouraging staff behavior. The CT was developed for the target group of nursing staff and nursing assistants, care supervisors, and activity coordinators and it is based on three theoretical traditions:

(1) Health psychology approaches applied to old age; (2) self-regulation and co-regulation approaches related to aging; and (3) life-span motivational models (see also Table 4).

Regarding *health psychology* the training builds on motivational theories (e.g. Self-Determination Theory by Deci & Ryan, 1985) which address the question why someone does or does not behave in a certain way. The framework of *Motivational Interviewing* or work on the *Positivity Bias*, for example, name ways to practically influence motivational components of behavior. *Self-regulation Approaches* (e.g., Social Cognitive Theory by Bandura, 1977) assume that persons can achieve their goals despite certain barriers (e.g., age-related functional impairments), as they selectively influence their actions, emotions, cognitions, or intentions, for instance. *Co-Regulation Approaches* address the question how certain ways of interacting and communicating (e.g., baby talk) may influence vulnerable persons' autonomy. The *knowledge on clinical action* is highly relevant in this context. *Life-span motivational models* (e.g., Socio-Emotional Selectivity Theory by Carstensen, 1991) assume a goal-focused, mainly conscious, and functionally adaptive process of selection and active arrangement of the social context that aims at an age-adequate re-

arrangement of the social context as well as at a (re-) activation of social resources in order to maintain well-being.

Though a large body of research identified factors promoting as well as factors preventing PA, research lacks findings concerning this matter in older persons, especially in the NH context. Regarding motivators and barriers of PA, factors like social support, self-efficacy, individual choice options, perceived security, regular performance feedback, or positive reward have been named. Furthermore, individually adjusted interventions including personal activity goals and the provision of information on local offers have been considered relevant. Regarding the special role of persons with dementia, it is relevant to enable them to get in touch with others, to give them the sense that they contribute something relevant, as well as to provide them the chance of reminiscence. The use of specific communication strategies (patients' education, self-monitoring, goal setting, verbal encouragement) is very important to motivate this target group.

Requirements and Aims of the Communication Training

Based on the theoretical and empirical foundations, the change in staff members' communicational and interactional behavior is meant to promote the following components on the part of the residents (see Table 4).

Table 4. Key Variables, Staff Requirements, and Intervention Contents

	Key Variables	Staff Requirements	Intervention Contents
Health psychology and motivational approaches	**Autonomy**	provide and grant residents leeway in decision-making, offer opportunities to try behavior	empathy, positive regard, value-free conversation (Rogers); the problem of the corruption effect; Motivational Interviewing
	Health benefit	sufficient knowledge on chances and risks; convey an optimistic view to residents	age-related attitudes and stereotypes
Self-regulation and co-regulation approaches, knowledge on clinical action	**Self-efficacy beliefs**	appreciate residents' competences, emphasize their confidence, encourage, consider fears	techniques to express positive, self-worth enhancing statements
	Control beliefs	support residents in attributing success to their own competences, failures to external sources; encourage residents to try again	role of control beliefs; techniques to express positive statements
	Self-regulatory competences	support residents to recognize and to use chances of selection, optimization, and compensation	develop chances of selection, optimization, and compensation
	Considering individual preferences	know residents' individual preferences and needs and respect these	techniques to explore needs
Life span approaches	**Social support, social exchange**	involve residents in social interactions to promote their activity; give residents the feeling of being important and needed	positive attitude towards PA; develop opportunities to connect PA with social interactions (e.g., involve residents in housework); safety concerns

Organizational Aspects

The competence training is offered to nursing staff and is integrated into their regular in-house training schedule to facilitate participation and to reach higher adherence rates. The training comprises twelve sessions: eight 1-hour-sessions including theoretical as well as practical contents and four 30-minutes-sessions serving as case discussions and feedback-loops. Each session is offered twice a week to facilitate staff attendance. To encourage motivation, compensatory time off or financial compensation for participants may be helpful. The 12-session training can be repeated regularly, e.g. every three or four months. In this way, new staff members are instructed and staff who already attended the training may use it as "refresher".

In order to establish an internal quality management, the program can be adapted the actual situation or new developments within the institution. Therefore, after each session staff members may fill out a short evaluation form. This instrument provides information on the following: interest in session content, structure and pace of session, comprehensibility and practical relevance of contents, learning effect, evaluation of practical exercises, response to personal matters, atmosphere, experienced fun during session, intention to attend next session, general evaluation, and possibility to provide additional comments. At the end of the 12-week training a more extensive evaluation may be conducted. In addition to the contents listed above it addresses consequences of the training and experiences with the practical use of newly acquired skills.

General Description of CT Contents

The CT consists of 12 weekly in-house-training sessions with two major parts (see also Table 5):

- Eight introducing sessions of 60 minutes containing especially theoretical aspects.
- Four intervision sessions of 30 minutes including case-oriented discussions and feedback-loops.

Because time limitations are a critical factor in the NH workplace, every session should be offered at least twice a week. Furthermore, extrinsic motivators like compensatory time off or financial reward are required to promote attendance.

Table 5. Contents of the CT for Staff Members

Session		Content
1	*Practical and theoretical aspects; discussions*	Introduction and overview over training program
2		Importance of PA in (old) age: theoretical input and joint discussion
3		Change of behavior: theoretical input and joint discussion
4		The role of age stereotypes in caring routines: theoretical input and joint discussion
5		Communication strategies I: Theoretical input and practical exercises
6		Communication strategies II: Theoretical input and practical exercises
7		Communication strategies III: Theoretical input and practical exercises
8		Feedback on practical application of communication strategies in caring routines and development of respective solutions
9-12	*Intervision*	Case discussion and development of respective solutions

Concerning the theoretical meta-perspective, the first modules (2-4) are based on health psychology as well as motivational approaches. Modules 5-8 mainly contain components from the self-regulation, co-regulation approaches and the agency of the knowledge on clinical action as well as life span approaches. “Applying methods” will majorly convey techniques of person-centered counseling according to Rogers as well as by Motivational Interviewing.

In the following, the sessions of CT will be described in more detail. Each session starts with a brief feedback on the previous session, followed bya discussion of unsolved issues if needed and ends with a short summary and outlook.

Specific Contents of Sessions

Session 1: Introduction

In the first session, staff members get an overview of the frame conditions and the contents of the intervention program. They are informed about the project’s mission, the innovative methods and the research staff involved. Furthermore, the potential positive consequences for residents as well as staff are highlighted.

The contents of the sessions to come are shortly addressed, an outlook is given and upcoming questions and doubts are discussed.

Session 2: Importance of PA in (old) age

In this session, staff members learn about the importance of PA in old age and in NHR in particular. The session starts with a joint reflection on personal reasons for being physically active or not before discussing pros and cons for being physically active in old age. Empirical data on demographic statistics as well as age stereotypes are presented with regard to PA and positive consequences of PA for older adults with and without cognitive impairment are addressed. Participants are informed about dementia-related changes in basic motor functions (e.g., gait disorders, limitation in sit-to-walk-transfer, risks of falling) and dementia-specific intervention techniques (e.g., specific communication strategies, individually tailored exercises).

Session 3: Change of behavior

This session is about change of PA-related behavior and potential challenges in this regard. After discussing individual experiences considering behavior change, the

difficulty to break behavioral habits (e.g., smoking, alcohol consumption) is illustrated. Information on the phases of behavior change is provided (pre-contemplation, contemplation, preparation, action, maintenance) and each phase is discussed with regard to PA in NHR (e.g., which factors keep NHR in a rather inactive status). Ways to overcome potential barriers are discussed jointly afterwards.

Session 4: The role of age stereotypes in caring routines

In this session, the role of age stereotypes in caring routines is discussed with regard to fostering the independency of NHR. Information about age stereotypes, gains, losses and risks associated with older age as well as the impact of subjective age (how old someone feels) are provided. Socially predominant age stereotypes are described and the resulting consequences are critically examined. For this purpose, video sequences are shown illustrating in an exemplary way, how different types of staff behavior can influence dependent vs. independent lifestyle of NHR. In a subsequent discussion, strategies promoting autonomy of NHR are worked out together.

Session 5-8: Communication strategies I-III

These sessions aim at PA-encouraging staff-resident interactions. Staff members get information about how to structure conversations actively. Techniques such as active listening, clear communication, paraphrasing, expressing contents personally and using meta-communication are presented in this regard. Special attention is drawn to dementia-specific communication techniques as well as to challenging conversation situations (e.g., dealing with anger, sadness, aggression, personal attacks). Offering practical exercises (e.g., role plays) staff members get extensive practice opportunities. Practical experiences with the new techniques made during the daily nursing care are discussed in the following session.

Session 9-12: Case discussion and development of respective solutions

The intervision sessions offer an opportunity to jointly discuss challenging single cases and develop respective solutions together. Furthermore, the practical application of the newly learned communication and interaction strategies are reviewed, and strategies for upcoming challenges are developed

ANNEX

Exercise Catalogue and Guidelines

Safety Measures & Safeguarding Positions

Tool for the Evaluation of Existing Activities

Training Group Assignment of Residents

Exercise Catalogue and Guidelines

This catalogue contains an exemplary compilation of exercises that are specifically suitable for use in nursing home residents. It mainly comprises a progressive functional and strength training as well as dual task exercises. By now there is a rather large amount of training programs that are based on similar exercises and principles. An extensive overview of interventions useful in the nursing home setting, including recommendations of particularly useful programs is given by Horn et al., 2012, e.g. *HIFE - High Intensity Functional Exercise Program* (Littbrand et al.), *SimA-P* (Oswald et al., 2007), *MIA* (Sportbund Bielefeld, 2009), or *Strength- and Functional Training for Older People with Dementia* (Schwenk et al., 2008).

In the following, the exercises will be assigned to the main motor skills that are trained with the exercise, although most exercises address multiple motor skills. Training is performed in static as well as dynamic standing positions and, depending on individual functional abilities, during walking. In the exercise catalogue basic exercises are described that can be adapted and varied in multiple ways. The exercises are implemented following three didactical principles:

- from low to high intensity
- from known to unknown tasks
- from simple to complex exercises.

With each exercise, we also describe alternatives and more complex variations of each exercise that can be used to further aggravate the exercises. In this way, exercises have constant high impacts and thus stronger effects on motor function. In general, exercise can always be developed further. Creativity is completely unrestrained as long as the exercises are functional, effective and safe.

Static Balance Training

B1: Side by Side Stance

Both feet are placed parallel in an upright stance, touching each other. This position should be held with as little movement as possible, as long as possible but no longer than 30s. If the person can hold this position with support, this can be done without support, under close supervision.

Alternative: High level performance: both eyes closed during exercise.

B2: Semi-Tandem Stance

This exercise builds up on B1 and poses higher demands on participants' balance due to the more complex location of the body's center of gravity. The starting position is similar to B1. Then, one foot is shifted to the front for about ten to 15 cm. The execution of this task is similar to B1.

B3: Tandem Stance

Just as B2, the Tandem Stance further increases the complexity of the standing task. Starting position is as in B1 and B2. Then, on foot is placed straight in front of the other foot. The execution of the exercise is as in B1 and B2.

Alternative: All three exercises can be performed on e.g. balance pads (B1a) or porcupine balls (B1b) to further increase complexity.

B4: Leg pendulum

The exercise requires the participant to stand straight on one leg, while the other leg is swung to the front and back like a pendulum. Initially, the person may hold on to a chair placed alongside the participant. The better a person can manage the task, the less aid should be used. After 30 seconds, the legs can be switched.

Alternative: The standing foot can be placed on an uneven underground (balance pad, porcupine ball, etc.) which increases the complexity of the task.

B5: Catching a ball

The person is standing straight and has a hand-sized ball in one or both hands. Depending on the experience with this exercise, the standing position can be varied (see B1 to B3).

The person throws the ball up in front of his/her face and catches it with both hands. As this exercise requires the use of both hands, direct contact with a supervisor is mandatory to ensure highest possible safety. To increase complexity, the task can be done with one handed throws and catches, different stances, and with different balls (exercise ball vs. tennis ball). By adding a complex motor-cognitive task such as throwing and catching a ball, keeping one's balance is made more difficult.

Alternative: This exercise can be performed as a partner exercise. Two or more persons are standing opposite to each other. For safety reasons, chairs can be placed behind and in front of the persons, in case they want to hold on to a chair. Then, the ball is thrown back and forth between the persons with one hand (if holding on to a chair; B5.1) or both hands (if standing freely; B5.2). Different balls or balloons (B5.3) can used to vary the exercise task.


B5.1


B5.2


B5.3

D1/D2: Lunges

In an upright stance, the person holds on to a chair in front with both hands. Then, a lunge to the side (S1) or to the front (S2) is performed. Lunges to the left and right can be performed either alternately or one side after the other; lunges to the front should be performed alternately with each side. The step has to be performed recognizably; the foot has to be lifted up in a distinct manner.

Alternative: To increase difficulty, the person can grab the chair with one hand (see Figure D1) or perform the exercise without support.

D3: Lunges with porcupine balls/ balance pads

To combine the stepping task with an aggravated balance task, porcupine balls and balance pads can be used. The starting point is the same as in S1. Porcupine balls or balance pads are placed in front of the person. The steps then have to be executed on the materials. The person can either hold on to a chair or be held with hands by the instructor. This exercise requires the ability to stand safe and a certain amount of strength, experience, and security of the instructor.

Alternative: To further aggravate the task, the participant can start already standing on two porcupine balls. In this way, a balance training of rather high intensity can be incorporated in the stepping task. Two modes are possible:

- Three balls; standing on two parallel balls and stepping on the ball in front;
- Four balls: from side-by-side on the two back balls (D3.1) through stepping forth (D3.2) to side-by-side on the two frontal balls (D3.3); and back again.

Dynamic Balance and Gait Training

G1: The stalker

The person has to walk with distinct and excessive knee lifts. Each step should be performed in a slow and deliberate manner. The supervisor has to walk close by and, if necessary, the person can hold on to the supervisor's hand until s/he is capable of walking independently. The length of the walking path can be adapted according to individual skills.

Alternative: This task can be performed under different conditions which increase difficulty and complexity: with eyes closed; back-wards; with different stepping patterns or paces.

G2: Walk the line

A slip-resistant rope is placed straight on the floor. The task is to balance on the rope with each step at least touching the rope. Ideally, the whole foot is placed on the rope with each step. The better this task is performed, the less support should be provided.

Alternative: To increase complexity, the rope can be lain in a wavy line; the task can be executed with eyes closed; steps can be performed as in G1; a ball can be included as in B5.

G3: Multi-task walk

Walking a distance is linked with certain motor-cognitive tasks, for example throwing and catching a ball (G3.1); solving tasks such as math problems; enumerating names, cities, animals, spelling words, or else. Close supervision is mandatory as cognitive tasks while walking increase the intensity and at the same time raise the risk of adverse events such as falls.

G4: Obstacle course

Many different materials can be used for the construction of an obstacle course that can be adapted according to individual preferences or deficits. The course should be adapted regarding obstacles length. Due to the higher complexity and intensity, obstacle courses should be shorter than the normal walking exercises. Such courses present an excellent way to train several motor skills simultaneously. In the following, different forms of obstacle courses are presented. In all of them, very close supervision and aid are mandatory as these are the most challenging exercises in a sample of NHR.

G4.1: Shaky ground walk

This course can be used to initiate obstacle courses in general. Terra Sensa® mats are very useful just as Airex® mats or any other balance pad. However, these are required to be slip-resistant. Otherwise, the risk of falls is very high.

G4.2: Balance mix

Balance pads can be combined with several other obstacles, such as ropes (G.4.2a) and porcupine balls (G4.2b). It is important to mind the distance between the obstacles, which should be adapted to the step length of each individual.

There are many options to combine materials, and no combination is inappropriate or false. It is possible to adapt the courses according to the training goals and/or participants' preferences to ensure efficiency, fun and enjoyment while doing the exercises.

G5: Get up and walk

Starting from a chair in a seated position, the person has to stand up and walk a certain distance turn around after passing an obstacle. In order to train balance as much as possible, this task should be executed in a very slow fashion.

Alternative: The exercise can be done as fast and quick as possible; while talking to the supervisor; with or without aid.

G6: Get up, walk and step

The execution of this exercise is similar to G5, with one exception: the person stops in front of the porcupine ball and performs alternating steps on the ball with the right and left foot, then returns to the chair.

Alternative: The person can stand on the ball with one foot and hold the position for ten seconds; then uses the other foot. The person walks back to the chair backwards.

Functional Strength Training

S1: Push the button

While standing, the person has to stand on a ball with one foot and push down the ball as hard as possible – then hold the pressure for about ten seconds (depending on the exhaustion of the individual). Balls with air outlet are particularly suitable as the fill up with air again once pressure is released. After ten rounds, the foot is switched.

Alternative: Instead of switching after ten rounds, the task can be performed alternately with the left and right foot to lay more focus on the stepping task.

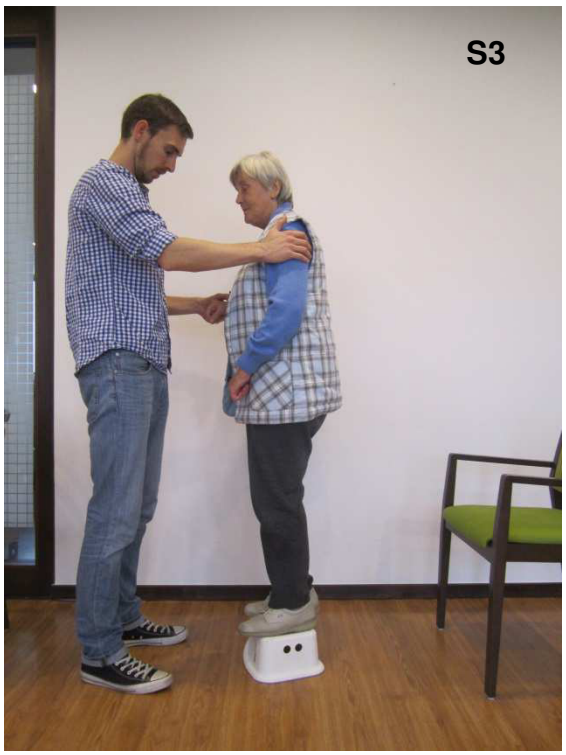
S2: Uplifting

The person is standing behind a chair and holding on to it. Then, ten to 15 calf-raises are performed. Depending on the individual strength of the participant, these can be done single-legged or with both legs and/or hands-free.

It has to be made sure that the person does not push her/himself up with help of the arms. This is also important for safety reasons as the chair may be torn down.

S3: Step up

The person has to step on a tread and down again. As many rounds as possible should be executed, but no more than 15 per leg. It can be done either one leg at a time or alternating with the right and left leg. If available, treads of different heights can be used, starting with the lowest for those with weak motor skills and highest for advanced stair climbing skills. For safety reasons, the supervisor should always stand close to the person.



S4: Chair rises

This exercise is intended to a) strengthen the lower extremity muscular system and b) train a proper chair rise technique in order to enable persons to stand up independently. Therefore, the chair rise task can be separated into three major parts that have to be performed five to twelve times:

S4.1: Slide to the front edge of the chair with feet positioned in shoulder width, directly below or slightly behind the knees.

S4.2: Lean forward until the shoulders are at the height of the knees.

S4.3: Stand up, if possible without momentum and use of hands.

Alternative: To increase the intensity of the task, balance pads can be put under the feet. If done so, an elevation of the sitting surface may be necessary. The slower the task is performed, the higher the intensity.
Another aggravation of the task would be not to put down the rear on the sitting surface but to rise again once it is slightly touched.

Seated Exercises

Many of the exercises above can be adapted to the needs and require-ments of persons who are not able to stand up or walk. There are also some more exercises that are especially for wheel-chair bound residents. They can be used for exercise groups as well as in individual single training as implemented in the project LTCMo.

W1: Riding a bike

The person is sitting on a (wheel)chair and leaning backwards. Then, both legs are lifted in the air and moved as

in cycling. One round should last ten to 30 seconds, depending on individual muscular endurance.

Alternative: The cycling can be done backwards; each cycle can be performed in a very slow manner; cycles can have a small or large diameter.

W2: Leg extensions

The person is seated on a chair and leaning backwards. A ball is clamped between both feet; the feet are slightly

above ground. Then, both legs are extended ten to 15 times with the ball still being clamped between feet.

The ball can be left out if a person is unable to keep it between feet.

W3: Knee raise

The person is seated nearer to the front edge of a chair; the back is kept straight; both feet are placed straight on the ground. Then, one leg is lifted straight up and held at the highest possible point for about two seconds. Legs are switched after each repetition.

Alternative: Both legs can be lifted at the same time; a ball can be clamped between both feet while the exercise is performed (W3.1).

W4: Push the button – seated

Seated position as in W3. A ball is placed under one foot and pushed down as hard as possible. Pressure should be held for about ten seconds (depending on the exhaustion of the individual). Soft balls or balls with air outlet are preferred; after ten rounds, the foot is switched.

Alternative: Instead of switching after ten rounds, the task can be performed alternately with the left and right foot.

W5: Kicking it

Two or more persons are seated facing each other and kicking one or two balls to and fro; both feet should be used.

Alternative: Smaller (tennis ball) or bigger (soccer ball) balls can be used; the ball can be kicked back immediately or stopped in between.

Safety Measures & Safeguarding Positions

Participants' safety is one of the most important issues when it comes to exercise training with frail older people. Therefore, we present the most important safety measures and precautions as well as safeguarding positions during exercises.

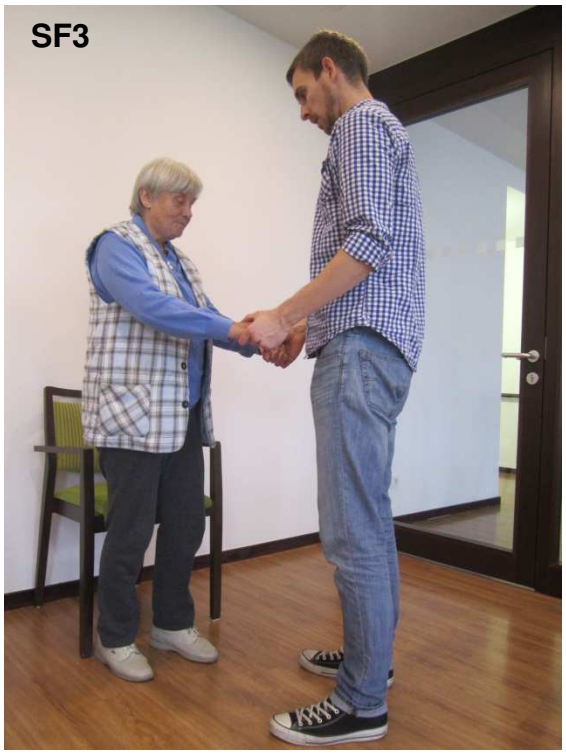
The **double chair circle** has already been mentioned. It is the most effective way to provide safety and prevent falls, especially in larger exercise groups. A proper double chair circle provides one chair within reach in front of a person and one in the back, close enough to sit down immediately without having to take a step backwards (SF1/SF2).

The better the motor function of a person gets, the less aid should be provided. However, safety has to be kept at the highest possible level throughout the training course. The balance between two somewhat opposing interests, safety and exercise effectiveness, has to be kept at all times. There are several ways to facilitate or aggravate an exercise for a person. Whether this is necessary or useful is always an individual decision that depends on the ability and experience of the instructor and the motivation and attitude of the exercising person. In the following, safety measures and safeguarding positions are presented from easy to difficult (meaning that the exercise becomes more complex and intense).

The easiest way to provide safety is to use the double chair circle with additional aid of the instructor. In this way, the participant can hold on to a chair and the instructor can provide additional aid and help performing the task. This is especially useful for participants who feel unsafe or have severe motor deficits.

If an instructor is sure that s/he can handle the task, the chair in front of the participant can be left out. Instead, the

instructor can stand in front of and hold the person by both hands (SF3).



To make the exercise more difficult for the participant, the instructor may take away one hand and place it on the shoulder. Still, the participant can hold on to the instructors' other hand (SF4).

If the instructor is sure that a person is able to do the exercise on his/her own, both hands can be placed near the shoulder or waist of the participant, so that the instructor can intervene immediately if necessary (SF5).

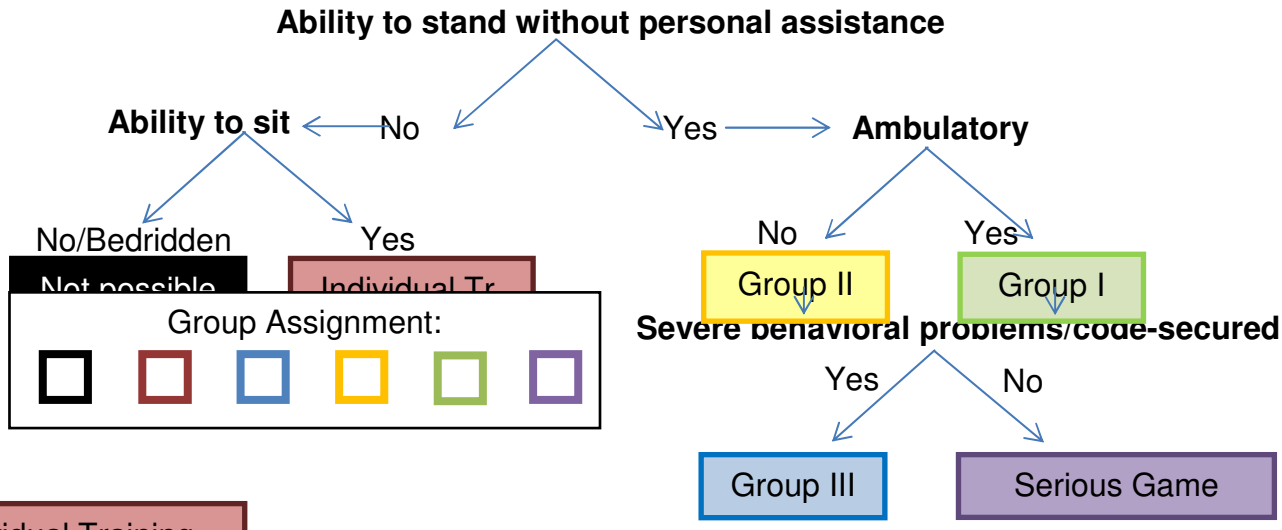
The closer the instructor stands to the person, the easier it is to intervene in a safe and uncomplicated manner.

The positions above can be used in almost all exercises. However, when walking, the instructor should walk alongside the participant and have one arm around shoulder or waist and one hand free to hold on to if necessary (e.g., see exercise G2).

Tool for the Evaluation of Existing Activities

Date & duration:	Rater/Observer:
Unit:	e.g. 1st floor unit
Activity:	☐ word of the day ☐ sitting-dance ☐ morning round ☐ evening round ☐ calisthenics ☐ painting / creativity group ☐ Wii-training ☐ fall prevention ☐ Other: _____
Participants (Residents):	overall: N=___ wheelchair users: N=___ walker-rollator users: N=___
Participants (Staff):	N= *(including trainers, interns, legal guardians, etc.)*
Profession of trainer:	☐ social care ☐ nurse ☐ honorary post ☐ other: _____
Short description of activities:	- main goal of activity: - performed activities: - amount of physical activity involved: - intensity of activities: - cognitive: - physical: - motivation of participants:
Potential use for project:	Grade ☐ A → of strong use; similar aims; only small modifications required (if necessary) ☐ B → medium to high potential; slightly different aims; may be useful if modified ☐ C → low potential; different aims; hardly any activity involved ☐ D →no potential; totally different aims; no activity involved
Modifications necessary:	

Training Group Assignment of Residents



Individual Training

- **Characteristics/Criteria:** Residents show severe motor impairment and or cognitive impairment in combination with severe behavioral problems. Independent standing is not possible and requires constant help of at least one supervisor. Explore, whether re-learning or improving standing is possible.
- **Aims:** Support of dynamic sitting; relearning of sit-to-stand transfer; advance to Group II or III.
- **Training Components:** In the beginning main focus on seated strength and mobilization exercises: strengthening of leg muscles (leg extension) to enable sit-to-stand transfers. In the course of the training, conduct standing exercises with support if possible.

Group I

- **Characteristics:** Ability to walk without aid; to stand up independently and sit down without any support; to walk longer distances without help.
- **Aims:** Physical activity promotion in terms of number and duration of active episodes; improvement of walking performance, dynamic postural control, and sit-to-stand/sit-to-walk transfers.
- **Training Components:**
  - Functional strength training: Sit-to-stand transfer training without using the arms.
  - Dynamic balance and gait training: Different standing positions; improvement of stability and duration of standing posture; different walking exercises (e.g., narrow vs. wide distance between feet; slow vs. fast walking; uneven floor surfaces)

Group II

- **Characteristics:** Unstable walking *with* aid; standing up and sitting down without personal assistance is possible.
- **Aims:** Physical activity promotion in terms of higher frequencies of standing and enabling participants to walk short distances. Improvement of static and dynamic balance (i.e., stable standing); improvement of sit-to-stand transfer. In the further course of the training: support of stable walking, walking security, and a homogeneous walking pattern (then: transition into Group I).
- **Training Components:**

- Support of stable standing without aid by exercising in different standing positions and at different levels of difficulty.
- Sit-to-stand training: trying to stand up and stand still; in the long run, transition to sit-to-walk training
- Gait training: In the beginning, improvement of gait performance with support; gait episodes without aid if this seems possible; prolongation of the duration of walking episodes under supervision and improvement of a homogeneous walking pattern.

Group III

- **Characteristics:** Participants show pronounced cognitive impairment accompanied by severe behavioral problems. Participants should be ambulatory and able to stand up with little or no support. In LTCMO, this group was implemented in a code-secured living unit.
- **Aims:** Improvement of static and dynamic balance (i.e., stable standing); improvement of sit-to-stand transfer. Support of stable walking, walking security, and a homogeneous walking pattern.
- **Training Components:**
  - Functional strength training: Sit-to-stand transfer training without using the arms.
  - Dynamic balance and gait training: Different standing positions; improvement of stability and duration of standing posture; different walking exercises (e.g., narrow vs. wide distance between feet; slow vs. fast walking; uneven floor surfaces)
  - Focus on social aspect of group training: exercising together by execution of clearly constructed and meaningful tasks.
- **Special Requirements:** Depending on the severity of cognitive impairment, group organization may require adaptations. In L TCMo, instead of a double chair circle, residents were seated side by side in direction of the hallway which was used for exercises. Then, residents were attended to one after another. When the last participant in the line was done with his round, the first in line started again. In this way, residents were seated close to each other so that social contact and conversations were facilitated. In addition, this organization form was found to be easier to understand for the participants than the double chair circle.

Serious Game

- **Characteristics:** Participants are able to stand and step independently and whot are not or mildly cognitively impaired.
- **Aims:** Improvement of motor-cognitive function and dynamic postural control.
- **Training Components:** A supervised cognitive-motor training. Participants have to execute steps (forward, backward, right or left) on a dance plate as indicated on a computer or TV screen.

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Project-Related Publications

Jansen, C.-P., Claßen, K., Hauer, K., Diegelmann, M., & Wahl, H.-W. (2014). Assessing the effect of a physical activity intervention in a nursing home ecology: A natural lab approach. *BMC Geriatrics*. Online published. doi:10.1186/1471-2318-14-117

Jansen, C.-P., Claßen, K., Wahl, H.-W., & Hauer, K. (2015). Effects of interventions on physical activity in nursing home residents. *European Journal of Ageing*, 12, 261-271. doi: 10.1007/s10433-015-0344-1

Disclaimer:

All contents of this Guidebook have been thoroughly reviewed before publication. Nevertheless, it may be the case that mistakes and wrong information are still part of the book. Given that this book offers guidelines, no less but also no more, we do not take any responsibility for events that may occur as part of a training based on this book. For example, all success depends on highly qualified instructors with large experience in working with older adults, particularly physically and mentally frail older adults.

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