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Habilitationsschrift

Determinanten und Prävention von körperlicher Inaktivität und Tabakkonsum in epidemiologischen Studien

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von

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Abkürzungen

BMG	Bundesministerium für Gesundheit
BMI	Body Mass Index
BZgA	Bundeszentrale für gesundheitliche Aufklärung
CDC	Centers for Disease Control and Prevention
COPD	Chronisch obstruktive Lungenerkrankung
DEDIPAC	Determinants of Diet and Physical Activity
DKFZ	Deutsches Krebsforschungszentrum
FCTC	Framework Convention on Tobacco Control
GEDA	Gesundheit in Deutschland aktuell
HEPA-PAT	Health-Enhancing Physical Activity Policy Audit Tool
KA	Körperliche Aktivität
Kcal	Kilokalorie
kg	Kilogramm
km/h	Stundenkilometer
m	Meter
MET	Metabolisches Äquivalent
ml	Milliliter
ÖGD	Öffentlicher Gesundheitsdienst
SES	sozioökonomischer Status
TCS	Tobacco Control Scale
WHO	World Health Organisation

„Wenn wir jedem Menschen die richtige Dosis Nahrung und Bewegung geben könnten, nicht zu viel und nicht zu wenig, hätten wir den besten Weg zur Gesundheit gefunden.“

- Hippokrates, ca. 460-377 v. Chr. -

1. Einleitung

1.1. Public Health

Public Health ist gemäß der World Health Organisation (WHO) die „Wissenschaft und Praxis der Prävention von Krankheiten, Verlängerung von Leben und Förderung von psychischer und physischer Gesundheit und Effizienz durch strukturierte Maßnahmen des Gemeinwesens. Public Health lässt sich begreifen als die Strukturen und Prozesse, über die durch strukturierte gesellschaftliche Maßnahmen die Gesundheit von Bevölkerungen verstanden, geschützt und gefördert wird.“ [1,2]. Public Health umfasst die multidisziplinäre wissenschaftliche Forschung an universitären Einrichtungen, die praktische Umsetzung an Public-Health-Instituten sowie die Umsetzung in der Gesundheits- und Sozialpolitik [3].

Eine der wichtigsten Errungenschaften von Public Health ist die enorme Steigerung der Lebenserwartung im Laufe des 20. Jahrhunderts in Deutschland und weltweit (Abbildung 1). In Deutschland ist sie zwischen 1900 und 2000 um 30 Jahre gestiegen, dabei spielten in der ersten Hälfte des Jahrhunderts vor allem Public Health-Maßnahmen wie verbesserte Hygiene und Ernährung sowie Fortschritte bei der Bekämpfung von Infektionskrankheiten eine entscheidende Rolle, die zu einem starken Rückgang der Säuglingssterblichkeit führten. In der zweiten Hälfte des Jahrhunderts stieg die Lebenserwartung zunehmend auch bei älteren Menschen, was zum großen Teil auf den medizinischen Fortschritt z.B. bei der Behandlung von Herz-Kreislauferkrankungen, zurückzuführen ist [4,5]. In Tabelle 1 sind die 10 wichtigsten globalen Errungenschaften, die zu der gestiegenen Lebenserwartung und der Verbesserung der Lebensqualität beigetragen haben, dargestellt. Außer der Fluoridierung des Trinkwassers gelten diese Errungenschaften auch für Deutschland.

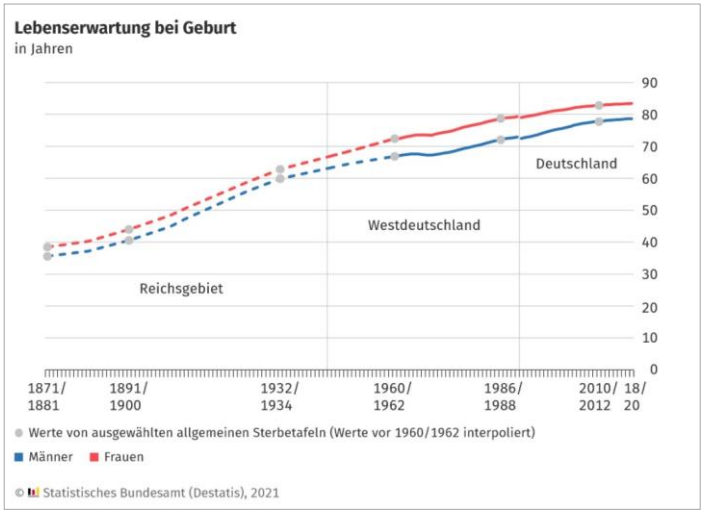

Abbildung 1. *Lebenserwartung bei Geburt in Deutschland.* Quelle: Statistisches Bundesamt [6].

Tabelle 1. Die wichtigsten Errungenschaften von Public Health im 20. Jahrhundert weltweit. [7]

	1900-1999 USA, Centers for Disease Control and Prevention (CDC)
1.	Impfungen
2.	Verkehrssicherheit
3.	Arbeitssicherheit
4.	Kontrolle der Infektionskrankheiten
5.	Abnahme der Todesfälle an koronarer Herzkrankheit und Schlaganfall
6.	Sichere und gesunde Lebensmittel
7.	Gesunde Mütter und Babys
8.	Familienplanung
9.	Fluoridierung des Trinkwassers (findet in Deutschland nicht statt)
10.	Erkennen von Tabak als Gesundheitsrisiko

Bezogen sich die Ziele von Public Health bis zu Beginn des 20. Jahrhunderts vor allem auf den Infektionsschutz, stellen in den meisten Ländern der Welt (mit Ausnahme sehr einkommensschwacher Länder) mittlerweile nicht übertragbare Krankheiten wie Herz-Kreislauferkrankungen, Diabetes, Krebs und Demenz die häufigsten Todesursachen dar, für die neue Maßnahmen etabliert werden müssen [8,9].

Public Health Maßnahmen werden je nach Ansatz und Strategie wie folgt eingeteilt [10]:

1. Bezogen auf den **zeitlichen Verlauf** einer Erkrankung:
   1.1. Primärprävention – dient der Inzidenzsenkung. Zielgruppe sind Gesunde.
   1.2. Sekundärprävention – dient der Früherkennung (z.B. Screenings). Zielgruppe sind Personen mit erhöhtem Risiko für eine bestimmte Erkrankung.
   1.3. Tertiärprävention – dient zur Verlangsamung bestehender Krankheiten und Vermeidung von Komplikationen/Spätfolgen. Zielgruppe sind Patienten mit chronischen Erkrankungen.
2. Bezogen auf die **Zielsetzung**:
   2.1. Verhaltensprävention – Ansatz der Verhaltensänderung beim Individuum.
   2.2. Verhältnisprävention – Ansatz der Umgestaltung der Lebens-, Lern-, Arbeits-, oder Wohnverhältnisse, um ein gesundheitsförderliches Umfeld zu schaffen.
3. Bezogen auf die **Zielgruppe**:
   3.1. Bevölkerungsprävention – Maßnahmen, deren Zielgruppe (theoretisch) die gesamte Bevölkerung ist.
   3.2. Hochrisikostrategie – Maßnahmen, die auf eine bestimmte Zielgruppe mit erhöhtem Risiko zugeschnitten sind.

Dabei kann jegliche Maßnahme meist jedem der drei Ansätze zugeordnet werden. Beispielsweise ist das Rauchverbot in öffentlichen Gebäuden gleichzeitig eine primärpräventive, eine verhältnispräventive sowie eine Bevölkerungspräventionsmaßnahme, während Warnhinweise auf Zigarettenschachteln primärpräventiv, verhaltenspräventiv und eine Risikostrategie sind.

Die Umsetzung von Public Health-Maßnahmen findet in Deutschland durch den Öffentlichen Gesundheitsdienst auf Bundes-, Landes- und Kommunalebene statt. Das Bundesministerium für Gesundheit (BMG) ist verantwortlich für die Erstellung von Gesetzen, wie z.B. dem 2015 verabschiedeten Präventionsgesetz zur Stärkung von Prävention und Vorsorge durch Krankenkassen und Ärzte sowie in Lebensbereichen wie Kita, Schule und am Arbeitsplatz [11]. Ebenso wurden in Zusammenarbeit mit dem „Kooperationsverbund gesundheitsziele.de“, in dem 70 Organisationen des deutschen Gesundheitswesens vertreten sind, die sogenannten Nationalen Gesundheitsziele für verschiedene Lebensbereiche und Krankheitsbilder entwickelt, beispielsweise „Gesund aufwachsen“ [12] oder „Tabakkonsum reduzieren“ [13,14]. Weitere Einrichtungen auf Bundesebene sind z.B. die Bundeszentrale für gesundheitliche Aufklärung (BZgA) [15], das Robert Koch-Institut (Epidemiologie und Gesundheitsberichterstattung) [16] und das Paul-Ehrlich-Institut (Impfstoffe) [17] als Fachbehörden im Geschäftsbereich des BMG. Auf Landesebene gibt es Landesministerien und Landesgesundheitsämter, auf kommunaler Ebene die Gesundheitsämter, deren vielfältige Aufgaben der kommunalen Gesundheitsförderung z.B. den Infektionsschutz, Reihenuntersuchungen, Impfangebote, aber auch Netzwerkarbeit umfassen [18].

Die Einbeziehung des ÖGD in die Nationale Public-Health-Strategie sollte 2018 durch das von der Gesundheitsministerkonferenz verabschiedete „Leitbild für einen modernen ÖGD“ gestärkt werden [19]. Auch das Zukunftsforum Public Health fordert eine stärkere Einbeziehung des ÖGD als wichtigen Akteur von Gesundheitsförderung in Deutschland [20]. Dass diese Forderungen nicht ausreichend umgesetzt wurden, wurde bereits 2019 im Präventionsbericht der Nationalen Präventionskonferenz betont [21], besonders deutlich wurde dies jedoch seit Beginn des Jahres 2020 vor allem im Rahmen der Coronapandemie, als viele Gesundheitsämter in Deutschland aufgrund mangelnder Ressourcen und unzureichender Pandemiepläne mit der umfassenden Kontaktpersonennachverfolgung von Coronainfizierten, Quarantäneüberwachungen und andere pandemieeindämmenden Aufgaben überfordert waren. Als Konsequenz daraus entstand im Jahr 2020 der „Pakt für den ÖGD“, der eine finanzielle Unterstützung für Personalaufbau, Digitalisierung und Stärkung seiner Attraktivität vorsieht [22,23].

1.2. Körperliche Aktivität

1.2.1. Definition

Die bis heute verwendete Definition von körperlicher Aktivität, Sport und körperlicher Fitness entwickelte Caspersen im Jahr 1985:

- „**Körperliche Aktivität** ist definiert als jegliche körperliche Bewegung, die durch Muskeln hervorgerufen wird und Energie verbraucht.
- **Sport** umfasst die geplante, strukturierte und wiederholte körperliche Aktivität, die das Ziel einer Verbesserung oder Aufrechterhaltung der körperlichen Fitness zum Ziel hat.
- **Körperliche Fitness** beschreibt eine Reihe von Eigenschaften, die Menschen haben oder entwickeln, die sich auf die Fähigkeit beziehen, körperliche Aktivität auszuüben.“ [24].

Die fünf Formen körperlicher Fitness umfassen Ausdauer, Kraft, Schnelligkeit, Koordination und Dehnbarkeit [25]. Körperliche Aktivität kann in unterschiedlichen Bereichen ausgeübt werden, z.B. als Freizeitaktivität oder Sport, zur Fortbewegung, während der Arbeit oder in der Schule sowie im Haushalt [26].
Darüber hinaus werden verschiedene Intensitäten körperlicher Aktivität unterschieden, nämlich **leichte** (z.B. Spazierengehen, langsames Fahrradfahren <50Watt oder Hausarbeit), **moderate** (z.B. schnelles Walken oder Fahrradfahren mit <16 Stundenkilometer (km/h)) und **anstrengende** körperliche Aktivität (z.B. joggen, Fahrradfahren mit >16km/h, schnelles Schwimmen). Zudem wird im Zusammenhang mit Aktivität seit mehreren Jahren auch sitzendes Verhalten im Allgemeinen sowie Bildschirmzeit im Speziellen als Risikofaktor für Übergewicht, kardiovaskuläre und metabolische Erkrankungen beschrieben [27,28].

Um den Energieverbrauch bei körperlicher Aktivität annähernd zu beschreiben, wird üblicherweise das metabolische Äquivalent (MET) verwendet. 1 MET ist der Energieverbrauch in Ruhe und wird wie folgt berechnet [26,29]:

$$\frac{3{,}5\ Milliliter\ (ml)\ Sauerstoffverbrauch}{Kilogramm\ (kg)\ Körpergewicht \times Stunde} \quad \text{oder} \quad \frac{1\ Kilokalorie\ (kcal)}{kg\ Körpergewicht \times Stunde}$$

Dabei bedeutet

0,8 - 1 MET: Sitzen oder Liegen
1 - <3 METs: leichte körperliche Aktivität (Energieverbrauch von <4 kcal/min),
3 - 6 METs: moderate körperliche Aktivität (4-7 kcal/min) und
>6 METs: anstrengende körperliche Aktivität (>7 kcal/min) [30].

Um den Energieverbrauch über eine bestimmte Dauer darzustellen, werden MET-Minuten oder MET-Stunden verwendet.

1.2.2. Gesundheitsrelevante Effekte von körperlicher Aktivität

Der positive Effekt von körperliche Aktivität auf die Gesundheit konnte in vielen Studien und systematischen Übersichtsarbeiten gezeigt werden [31] (Abbildung 2).

Abbildung 2. *Schematische Darstellung gesundheitlicher Effekte von körperlicher Aktivität.*
Quelle: Europäische Informationszentrum für Lebensmittel (EUFIC) https://www.eufic.org/en/healthy-living/article/9-proven-benefits-of-physical-activity

So kann durch körperliche Aktivität das Risiko für kardiovaskuläre und endokrinologische Erkrankungen gesenkt werden [32,33], ebenso profitieren Patienten mit bereits bestehenden chronischen kardiovaskulären Erkrankungen von körperlicher Aktivität [34]. Bei Diabetespatienten können durch körperliche Aktivität in Verbindung mit weiteren Lebensstiländerungen z.T. bessere Effekte in der Diabeteskontrolle erzielt werden als durch Medikation [35].

Das Risiko für einige Krebsarten (z.B. Brust- und Dickdarmkrebs) kann durch körperliche Aktivität gesenkt werden [36,37], und Krebspatienten profitieren nach erfolgter Behandlung von regelmäßiger körperlicher Aktivität in Bezug auf Rekonvaleszenz, Rezidivrisiko und krebs-assoziierte Fatigue [38–40].

Die mentale Gesundheit ist ebenfalls durch körperliche Aktivität beeinflussbar, so konnte der positive Effekt bei Depression und Angsterkrankungen [41], aber auch die Wirkung auf das Gedächtnis und die kognitive Leistungsfähigkeit bei älteren Menschen gezeigt werden [42,43].

Weitere positive Effekte sind Stressreduktion, sowie eine gesteigerte Resilienz und sozialisierende Aspekte, die vor allem bei Gruppensport zu beobachten sind, sowie die Steigerung der Lebensqualität [44,45].

Zudem zeigen Studien eine reduzierte kardiovaskuläre, krebsbezogene sowie Gesamtmortalität bei Menschen, die regelmäßig körperlich aktiv sind [33,46,47].

1.2.3. Aktuelle Empfehlungen zu körperlicher Aktivität

Im Jahr 2018 hat die WHO ihren „Global action plan“ aktualisiert und – ausgehend von 2018 - als Ziel eine Reduktion körperlicher Inaktivität von Kindern, Jugendlichen und Erwachsenen um 15% bis zum Jahr 2030 gesetzt [48] (Abbildung 3).

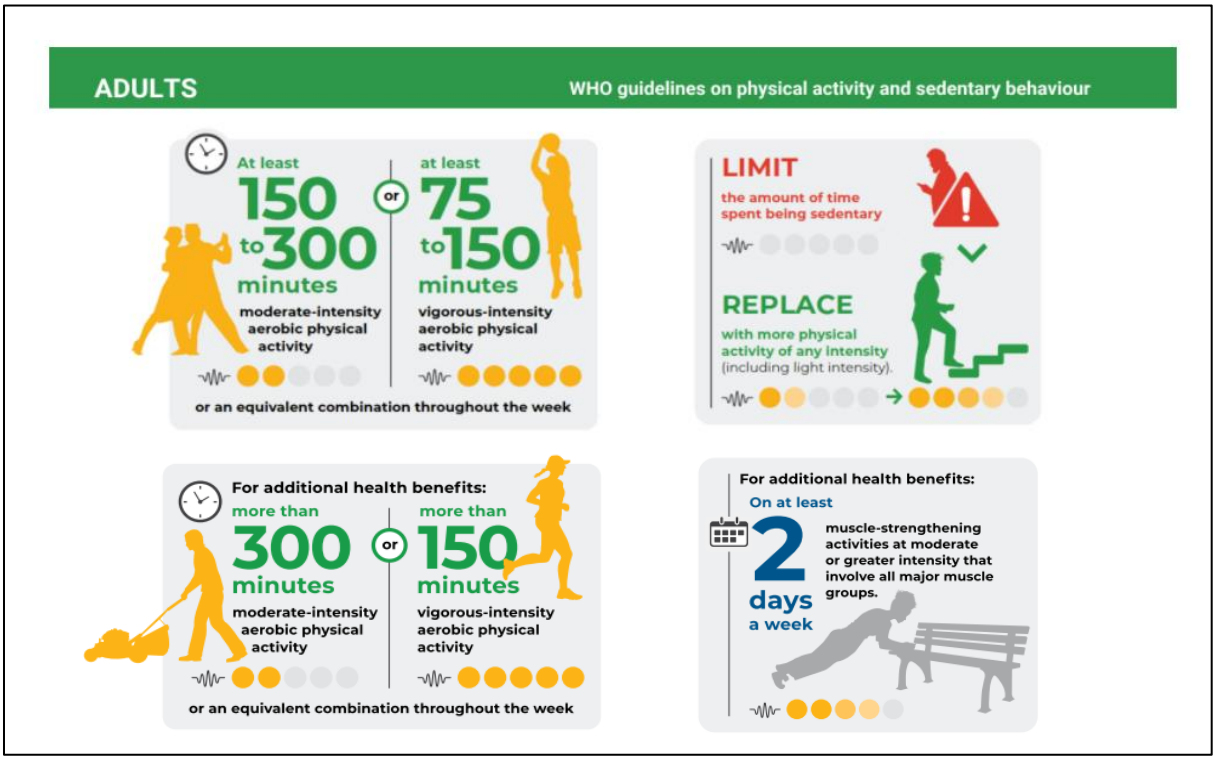

Abbildung 3. *Empfehlungen zu körperlicher Aktivität.* Quelle: WHO guidelines on physical activity and sedentary behaviour [49].

Als Folge wurden auch die Empfehlungen der WHO bezüglich Dauer, Häufigkeit und Intensität von körperlicher Aktivität überarbeitet [50–52]. Die Empfehlungen lauten nun, dass jeder Erwachsene 150-300 Minuten moderater oder 75-150 Minuten anstrengender oder jegliche äquivalente Kombination aus moderater und anstrengender körperlicher Aktivität pro Woche ausüben sollte. Im Gegensatz zu den früheren Empfehlungen kann die Aktivität frei über die Woche verteilt werden (früher 30 Minuten an 5 Tagen pro Woche), und sie muss nicht mehr in Einheiten von mindestens 10 Minuten absolviert werden [52,53].

Sitzendes Verhalten sollte so weit wie möglich reduziert werden, viel Sitzen kann durch mehr körperliche Aktivität ausgeglichen werden. Eine Angabe zur maximalen Dauer des Sitzens wird aufgrund mangelnder Evidenz nicht gegeben. Um den positiven Effekt noch weiter zu erhöhen, empfiehlt die WHO, die Dauer der Aktivität zu erhöhen (>300 Minuten moderate bzw. >150 Minuten anstrengende Aktivität) sowie zweimal pro Woche ein Krafttraining durchzuführen. Kinder und Jugendliche bis 17 Jahren sollten jeden Tag durchschnittlich 60 Minuten moderate bis anstrengende körperliche Aktivität ausführen, um einen gesundheitlichen Nutzen zu haben. Als Zielgruppen ergänzt wurden in den neuen Empfehlungen nun auch Schwangere, chronisch Kranke und körperlich eingeschränkte Menschen, für die im Großen und Ganzen die gleichen Empfehlungen gelten, die bisher aber nicht explizit erwähnt wurden [49,51].

1.2.4. Epidemiologie und Determinanten von körperlicher Inaktivität

Im Jahr 2016 waren weltweit 27,5% der Erwachsenen körperlich unzureichend aktiv. Dies betraf Frauen (30,7%) mehr als Männer (23,4%) sowie einkommensstarke (36,8%) mehr als einkommensschwache Länder (16,2%) [54]. Bei Kindern und Jugendlichen war die Prävalenz der Inaktivität deutlich höher. Durchschnittlich waren 81% der 11- bis 17-Jährigen nicht ausreichend aktiv, wobei Jungen (77,6%) etwas seltener inaktiv waren als Mädchen (84,7%). Länderunterschiede waren nicht so ausgeprägt wie unter Erwachsenen [55].

In Deutschland gaben bei einer Befragung des Robert Koch-Instituts im Rahmen der GEDA-Studie (2014/15) 42,8% der Frauen und 48,0% der Männer an, mindesten 2,5 Stunden pro Woche moderat körperlich aktiv zu sein. Allerdings erfüllten nur 27,6% der Frauen und 31,2% der Männer die Empfehlungen zu Krafttraining und damit nur 20,5% der Frauen und 24,7% der Männer die Gesamtempfehlung der WHO zur Kombination von Ausdaueraktivitäten und Krafttraining [56]. Seit der letzten Befragung im Rahmen der GEDA-Studie von 2009 sind die Anteile relativ stabil geblieben (unter den Frauen gaben damals 38,1%, unter den Männern 46,1% an, mindestens 2,5 Stunden pro Woche körperlich aktiv zu sein) [57]. Durch die neuen Empfehlungen der WHO ist es möglich, dass sich die Ergebnisse neuerer Studien in eine positivere Richtung verändern, sofern in den Befragungsinstrumenten die neuen WHO-Empfehlungen umgesetzt werden.

Unter den 3- bis 17-jährigen Kindern in Deutschland erfüllen nur 22,4% der Mädchen und 29,4% der Jungen die Empfehlungen von 60 Minuten moderater bis anstrengender Aktivität pro Tag [58]. Die „Health Behavior in School-aged Children“-Studie zeigte für 11- bis 15-Jährige deutlich niedrigere Zahlen, hier erfüllten 10,1% der Mädchen und 16,9% der Jungen die WHO-Empfehlungen, wobei die 11-Jährigen am häufigsten die Empfehlungen erfüllten (14,2% der Mädchen und 21,3% der Jungen) [59].

Diese Prävalenzen zeigen, dass es einen deutlichen Bedarf an einer Steigerung der körperlichen Aktivität in der deutschen Bevölkerung gibt. Es gibt eine Vielzahl an Faktoren, die auf individueller oder auf Bevölkerungsebene das Bewegungsverhalten beeinflussen. Der Determinants of Diet and Physical Activity (DEDIPAC) Knowledge Hub, 2013-2016, hat im Rahmen der „Healthy Diet for a Healthy Life“ European Joint Programming diese Faktoren untersucht [60].

Die Ziele waren

1. Bewertung und Harmonisierung von Methoden für zukünftige Forschung, Überwachung, Beobachtung und Bewertung von Interventionen und Maßnahmen in den Bereichen Ernährung, körperlicher Aktivität und sitzendem Verhalten;
2. die Identifikation der wichtigsten Determinanten für die drei Verhaltensweisen und
3. die Evaluation bereits bestehender Public Health-Maßnahmen. [61]

Abbildung 4 zeigt Beispiele für biologische [62], psychologische [63], verhaltensbezogene [64], sozio-kulturelle [65], umweltbezogene [66] sowie migrationsspezifische [67] Determinanten. Diese sind nicht isoliert zu betrachten, sondern können sich gegenseitig beeinflussen, wie z.B. Umweltfaktoren sich auf das individuelle Verhalten auswirken können.

1.2.5. Maßnahmen zur Steigerung der körperlichen Aktivität in der Bevölkerung

So wie körperliche Aktivität können auch Maßnahmen zu ihrer Förderung in verschiedenen Kontexten stattfinden. Es werden zwei Hauptansätze unterschieden, die sich jedoch nicht gegenseitig ausschließen und kombiniert werden können. Zum einen gibt es verhaltenspräventive Maßnahmen, wie z.B. Aufklärung in Kita, Schule, im Arbeitsumfeld oder beim Arztbesuch. Auch Informationskampagnen mit Plakaten, Flyern, Onlineangeboten o.ä. zählen dazu. Verhältnispräventive Maßnahmen dagegen umfassen z.B. den Ausbau von Fahrradwegen, die Umgestaltung oder Begrünung von Wohnraum, den Bau von Spiel- und Sportplätzen, aber auch architektonische Veränderungen in öffentlichen Gebäuden, die die Wahrscheinlichkeit der Treppennutzung erhöhen. Für jede Intervention sollte neben diesem Ansatz die Zielgruppe klar definiert sein.

Abbildung 4. *Determinanten für körperliche Aktivität (eigene Darstellung). KA: körperliche Aktivität*

In Deutschland gibt es bisher vier zentrale politische Dokumente, die sich mit der Förderung körperlicher Aktivität in der Bevölkerung befassen. Diese sind der „Nationale Aktionsplan zur Prävention von Fehlernährung, Bewegungsmangel, Übergewicht und damit zusammenhängenden Krankheiten 2008“ mit dem Projekt „IN FORM“ [68,69], das 2015 erlassene Präventionsgesetz [11], die „Nationalen Empfehlungen für Bewegung und Bewegungsförderung“ von 2016 [70] sowie der „Nationale Radverkehrsplan 3.0“ [71].

Während IN FORM von 2008 gezielt auf die Förderung von gesunder Ernährung und Bewegung ausgerichtet war, wurden im Präventionsgesetz von 2015 keine expliziten Maßnahmen zur Bewegungsförderung verankert. Die Nationalen Empfehlungen für Bewegung und Bewegungsförderung von 2016 sind als Teilprojekt aus IN FORM hervorgegangen. Der 2021 aktualisierte Nationale Radverkehrsplan, erstmalig entwickelt im Jahr 2012, hat das konkrete Ziel, den Anteil des Radverkehrs durch besseren Ausbau und Sicherheit des Radverkehrsnetzes zu erhöhen.

Im Rahmen von IN FORM wurden bis 2016 ca. 200 Projekte gefördert, die teils auf kommunaler, teils auf noch lokalerer Ebene durchgeführt wurden. Eine Evaluation der im Rahmen dieses Projektes implementierten Maßnahmen durch Experten aus Wissenschaft, Sportverbänden und anderen Bereichen der Bewegungsförderung ergab, dass es sich vor allem um Einzelprojekte mit eher kurzfristigen Zielen handelte und die „Bewegungsförderungslandschaft derzeit noch als fragmentiert einzuschätzen“ sei [72].

Die daraus abgeleiteten Handlungsempfehlungen enthalten daher unter anderem die

- Entwicklung integrierter und intersektoraler Strategien
- politische Unterstützung bei der Weiterentwicklung der Bewegungsförderung sowie bei der Verstärkung von Alltagsbewegungen
- Stärkung der Verhältnisprävention statt wie bisher Fokussierung v.a. auf Verhaltensprävention

Auch im offiziellen Abschlussbericht des IN FORM-Projekts wird den Einzelprojekten keine allgemeingültige Aussagekraft zu den erzielten Ergebnissen bescheinigt: „Übergreifend ist festzustellen, dass die Projektevaluationen bislang selten so angelegt sind, dass sie belastbare Aussagen dazu liefern, ob/in welchem Umfang die Projektinterventionen einen Beitrag zur Erreichung der genannten Resultate leisten, diese also als Wirkungen der Projekte anzusehen sind. Es ist deshalb aktuell kaum möglich, datenbasiert zu beantworten, welches wirksame Interventionen der Gesundheitsförderung und Prävention sind.“ [73].

Die Entwicklung der „Nationalen Empfehlungen für Bewegung und Bewegungsförderung“ fand im Rahmen von IN FORM statt [74]. Neben Empfehlungen bezüglich körperlicher Aktivität für Kinder, Jugendliche, Erwachsene, Ältere, chronisch Kranke enthält der Report auch Vorschläge zur ihrer Umsetzung und Dissemination in der Bevölkerung [70]. Allerdings richten

sie sich vorrangig an Fachpublikum und dienen nicht als Informationsmaterial für die breite Bevölkerung.

Im Jahr 2019 führten Messing et al. eine Analyse der bestehenden politischen Strukturen zur Bewegungsförderung anhand des Health-Enhancing Physical Activity (HEPA) Policy Audit Tool (PAT) durch, einem Instrument der WHO zur Politikanalyse auf nationaler Ebene [75,76]. Eines der wichtigsten Ergebnisse der Analyse war die Feststellung, dass Deutschland, im Gegensatz zu den WHO-Empfehlungen, kein Ziel zur Reduzierung der Inaktivität formuliert hat. Erfolg oder Misserfolg implementierter Maßnahmen können dadurch nicht evaluiert werden. Des Weiteren gibt es im internationalen Vergleich wenige gesetzliche Regelungen zur Bewegungsförderung, was sich besonders im Bildungssektor negativ widerspiegelt. Die Situation wird durch die föderale Bildungspolitik noch erschwert.

Auch aus ökonomischer Sicht ist Inaktivität in der Bevölkerung relevant. Sie verursachte 2015 4,8% der gesamten nationalen Gesundheitsausgaben. Ausreichend körperliche Aktivität hätte beispielsweise Kosten in Höhe von 213 Millionen Euro für Behandlungskosten von Diabetes Typ 2, 706 Mio. Euro von indirekten Kosten durch Produktivitätsverluste aufgrund von koronarer Herzkrankheit oder 1,03 Milliarden Euro von indirekten Kosten durch Produktivitätsverluste aufgrund von psychischen Erkrankungen einsparen können [77].

Während die theoretischen Voraussetzungen für Bewegungsförderung durch politische Dokumente und durch Verantwortlichkeiten auf unterschiedlichen Ebenen (Bundes-, Länder- sowie kommunaler Ebene) bereits vorhanden sind, sind die Strukturen zur Bewegungsförderung noch nicht ausreichend. Würden unterschiedliche Sektoren besser miteinander verknüpft, könnte das die Entstehung von Synergieeffekten fördern und würde im weiteren Verlauf zu einer Diffusion von Maßnahmen zur Bewegungsförderung in verschiedenste Lebensbereiche möglich machen (entsprechend dem Health in All Policies-Ansatz der WHO [78]).

1.3. Tabakkonsum

1.3.1. Gesundheitsschädliche Effekte des Rauchens

In Deutschland sterben jährlich 127.000 Menschen an den Folgen des Rauchens [79]. Rauchen schadet der Gesundheit durch mannigfaltige pathophysiologische Prozesse in nahezu allen Organsystemen (Abbildung 5).

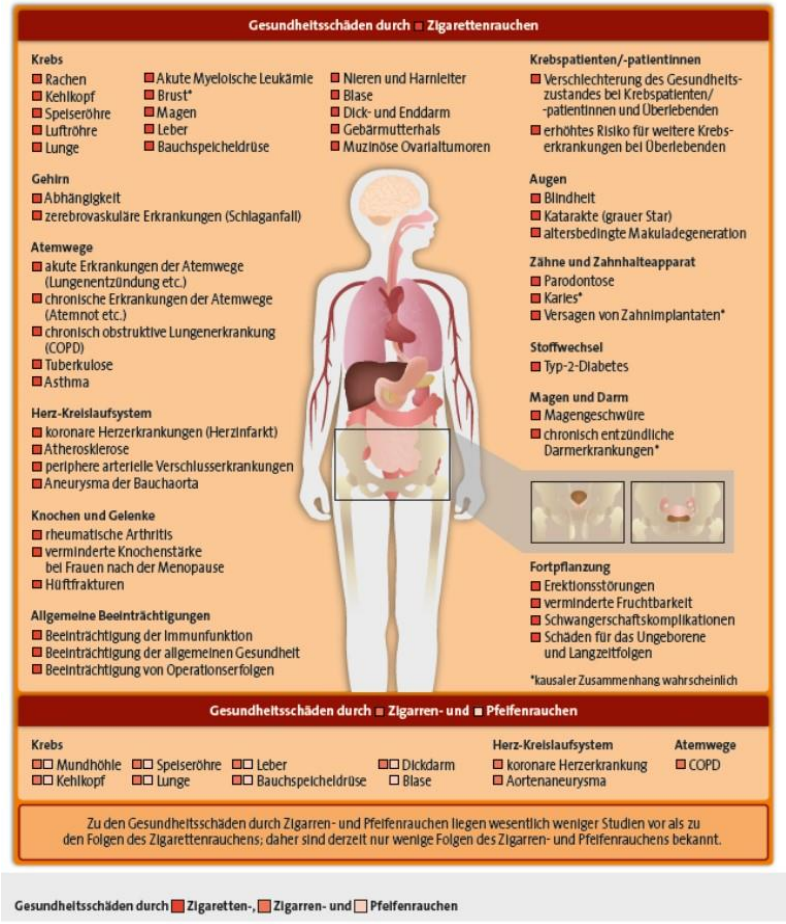

Abbildung 5. *Gesundheitsschäden durch Rauchen.* Quelle: Tabakatlas 2020 [79].

So sind die häufigsten direkten Folgen des Rauchens Herz-Kreislauferkrankungen, Krebs (z.B. Lunge, Rachen, Kehlkopf, Speiseröhre u.v.m.) und Lungenerkrankungen (z.B. chronisch obstruktive Lungenerkrankung (COPD)), aber auch andere Folgen wie eine Abhängigkeitsentwicklung, Schwächung des Immunsystems, Verringerung der Fertilität und viele andere können durch Tabakkonsum hervorgerufen werden [80–84]. In Deutschland waren im Jahr 2013 13,3% aller Todesfälle auf die Folgen des Rauchens zurückzuführen. Dabei machten Krebserkrankungen fast die Hälfte, Herz-Kreislauferkrankungen fast ein Drittel und Atemwegserkrankungen etwa ein Viertel der Todesursachen aus [85].

1.3.2. Epidemiologie und Determinanten des Rauchens

Obwohl seit den 1990er Jahren ein rückläufiger Trend des Rauchens zu beobachten ist, gaben im Jahr 2017 immer noch 22,4% aller Deutschen (Männer: 26,4%; Frauen: 18,6%) an, regelmäßig zu rauchen [86] (Abbildung 6). Im Jahr 1992 lagen die Werte noch bei 36,8% (Männer) und 21,5% (Frauen) [87]. Auch bei Jugendlichen geht die Raucherprävalenz zurück. Die KIGGS-Studie zeigte unter den 11-17-Jährigen einen Rückgang der Raucher von 21,4% (2003-2006) auf 7,2% (2014-2017) [88].

Eine wichtige Determinante für das Rauchen ist ein niedriger sozioökonomischer Status (SES) (gemessen am Bildungsniveau, an der beruflichen Stellung und an der Einkommenssituation), wobei der Bildungsstatus einen besonders großen Einfluss hat. Auch Jugendliche, deren Eltern einen niedrigen SES haben, rauchen bereits häufiger als Kinder von Eltern mit einem höheren SES (Abbildung 6). Rauchende Eltern sind ebenfalls ein Faktor, der das Rauchen von Jugendlichen begünstigt [79,86].

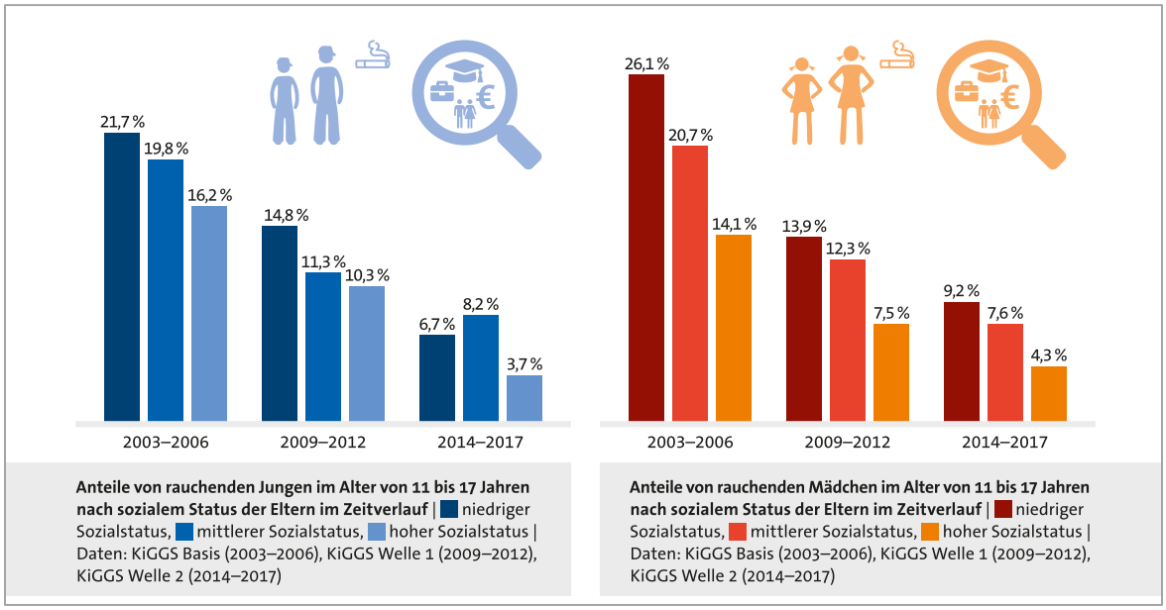

Abbildung 6. *Entwicklung der Anteile von rauchenden Jugendlichen stratifiziert nach dem Sozialstatus der Eltern.* Quelle: Tabakatlas 2020 [79].

Erwerbstätige rauchen seltener als Erwerbslose, und Menschen mit höherem Berufsstatus rauchen seltener als Menschen mit niedrigem Berufsstatus. Einzelne Berufsgruppen zeigen dabei sehr hohe Raucheranteile von ca. 50%, z.B. Personen, die in der Abfallentsorgung oder Gebäudereinigung arbeiten, aber auch Kellner und anderes Gastronomiepersonal. Den niedrigsten Raucheranteil haben lehrende Berufe sowie Ingenieure und Ärzte mit unter 15% [89].

1.3.3. Maßnahmen zur Senkung der Raucherprävalenz

Bereits im Jahr 2004 hat sich Deutschland durch die Unterzeichnung und Ratifizierung des WHO-Rahmenübereinkommens zur Eindämmung des Tabakgebrauchs (Framework Convention on Tobacco Control, FCTC) verpflichtet, den Nichtraucherschutz durch Maßnahmen wie die Erhöhung der Tabaksteuer, Werbeverbote oder Aufdrucken von Warnhinweisen auf Zigarettenschachteln voranzutreiben [90]. Dies wurde bislang nur teilweise und sehr zögerlich umgesetzt, obwohl es klare Evidenz für die Wirksamkeit dieser Maßnahmen gibt [91,92].

Auf der Tabakkontrollskala (Tobacco Control Scale (TCS), siehe Tabelle 2), einer Rankingliste, die alle 3 Jahre von der Assoziation Europäischer Krebsgesellschaften veröffentlicht wird und auf der die bereits umgesetzten Maßnahmen zur Tabakkontrolle mit Punkten bewertet werden, steht Deutschland auf dem letzten Platz (Platz 36) [93]. Deutschland ist z.B. das einzige der 36 Länder, das noch Außenwerbung für Zigaretten erlaubt. Aber auch beim Zigarettenpreis, bei der Umsetzung des Rauchverbots auf öffentlichen Plätzen und in Gebäuden, dem Anbringen von Warnhinweisen auf Zigarettenschachteln oder den Angeboten zur Rauchentwöhnung wurde bisher zu wenig der im FCTC beschlossenen Maßnahmen umgesetzt.

Tabelle 2. Tobacco Control Scale 2019.

Tobacco Control Scale 2019	Score Deutschland	Maximal erreichbarer Score
Zigarettenpreis / Erhöhung der Tabaksteuer	14	30
Rauchverbot auf öffentlichen Plätzen/Gebäuden	11	22
Budget	0	10
Werbeverbot	4	13
Warnhinweise auf Zigarettenschachteln	5	10
Unterstützung bei der Rauchentwöhnung	4	10
Bekämpfung illegalen Handels	2	3
Verhinderung einer Einmischung der Tabakindustrie (Art. 5.3 des FCTC)	0	2

Der Punkt „Verhinderung einer Einmischung der Tabakindustrie“ wurde bei der letzten Überarbeitung der TCS neu hinzugefügt. Seine Erfüllung dürfte besonders Deutschland vor große Schwierigkeiten stellen. Der Index zur Einflussnahme der Tabakindustrie betrug für Deutschland im Jahr 2020 63 von 100 Punkten, im Jahr 2021 stieg er auf 68 Punkte [94,95].

Konkrete Maßnahmen, die derzeit in Deutschland durchführt werden, sind z.B. die Informationskampagnen der BZgA „Be smart don’t start“ für Schüler [96] und „rauchfrei“ für Jugendliche und Erwachsene [97,98].

Im Jahr 2021 wurde darüber hinaus die neue Kampagne „Nutze deine Chance“ vom BMG und der Bundesdrogenbeauftragten ins Leben gerufen [99,100], die vom Deutschen Krebsforschungszentrum (DKFZ) unterstützt wird.

Das DKFZ hat im Jahr 2021 die „Strategie für ein tabakfreies Deutschland 2040“ herausgegeben. Ziel ist es, dass im Jahr 2040 weniger als 5% der Erwachsenen und weniger als 2% der Jugendlichen in Deutschland Tabakprodukte oder E-Zigaretten konsumieren [101]. Die Autoren nennen 10 übergeordnete Maßnahmen und geben Empfehlungen zur konkreten Umsetzung, wie beispielsweise die Fokussierung auf vulnerable Gruppen wie Personen mit niedrigem sozioökonomischem Status oder Kinder (Abbildung 7).

Abbildung 7. *Maßnahmen zur Reduzierung der Raucherprävalenz in Deutschland.* Quelle: Strategie für ein tabakfreies Deutschland 2040 [101].

1.4. Zielstellungen der vorliegenden Originalarbeiten

1.4.1. Untersuchung von Determinanten für körperliche Aktivität

Das Ziel der in dieser Schrift vorgestellten Originalarbeiten war es, Dauer und Intensität sowie Determinanten von körperlicher Aktivität in der deutschen Bevölkerung zu beschreiben. Dazu wurden zum einen eine Quer- und eine Längsschnittstudie in einer Schülerkohorte durchgeführt, die Häufigkeiten für körperliche Aktivität und Bildschirmzeit sowie mit ihnen assoziierte Faktoren untersucht haben.

Des Weiteren wurde eine türkeistämmige Population in zwei weiteren Längsschnittstudien untersucht. Die erste Studie beschrieb Aktivitätsverläufe über einen Zeitraum von 6 Jahren sowie Prädiktoren für einen positiven Verlauf, die zweite Studie beleuchtete die Auswirkungen der Maßnahmen zur Viruseindämmung während der Coronapandemie auf die körperliche Aktivität und das Sitzverhalten.

1.4.2. Evaluation von Präventionsprogrammen am Beispiel von körperlicher Aktivität und Tabakkonsum

Während in den Beobachtungsstudien die Prävalenz und Determinanten von körperlicher Aktivität und sitzendem Verhalten beschrieben wurden, fokussierten die beiden Interventionsstudien auf Effekte von Präventionsprogrammen.

Die erste Studie untersuchte die Auswirkungen eines 8-wöchigen Krafttrainings zweimal wöchentlich bei hochaltrigen und in ihrer Mobilität eingeschränkten Bewohnern von Pflegeheimen. Ziel war es, die Effekte der Intervention auf die Mobilität und die Kraft der Teilnehmenden zu messen.

In der zweiten Studie wurde ein Tabakpräventionsprogramm für Jugendliche untersucht und im Rahmen einer dreiarmigen cluster-randomisierten Interventionsstudie evaluiert. Die drei Gruppen erhielten entweder a) eine Schülerintervention, b) eine Schüler- und Elternintervention oder c) eine Kontrollintervention. Ziel war es, die Effekte dieser Programme 2 Jahre nach der Teilnahme der Schüler zu messen.

2. Eigene Originalarbeiten

2.1. Demographische und sozioökonomische Determinanten für körperliche Aktivität in urbanen Settings

2.1.1. Determinanten von körperlicher Aktivität und Bildschirmzeit bei Berliner Jugendlichen – Querschnittsanalyse

***Krist, L.**, Bürger, C., Ströbele-Benschop, N., Roll, S., Lotz, F., Rieckmann, N., Müller-Nordhorn, J., Willich, S.N., Müller-Riemenschneider, F.:* Association of individual and neighbourhood socioeconomic status with physical activity and screen time in seventh-grade boys and girls in Berlin, Germany: a cross-sectional study. *BMJ Open. 2017;7(12):e017974.*

Körperliche Aktivität im Kindes- und Jugendalter ist ein wichtiger Einflussfaktor für körperliche und psychische Gesundheit. Gleichsam ist sie ein Prädiktor für körperliche Aktivität im weiteren Lebensverlauf und daher wesentlich verantwortlich für einen guten Gesundheitsstatus im Erwachsenenalter.
Studien zeigen, dass körperliche Aktivität und Bildschirmzeit bei Jugendlichen unter anderem mit dem Geschlecht, dem Body Mass Index (BMI) sowie dem sozioökonomischen Status und der Bildung der Eltern assoziiert sind. Das Ziel der vorliegenden Studie war, darüber hinaus den sogenannten Sozialindex einzubeziehen, der in Berlin für kleinere Einheiten der Stadtteile, die sogenannten Planungsräume, erstellt wird und den durchschnittlichen sozioökonomischen Status der dort lebenden Bevölkerung widerspiegelt. Einbezogen wurden der Sozialindex des Wohnortes der Schüler sowie der Schulen. Außerdem wurde der Schultyp (Gymnasium oder Integrierte Sekundarschule) als möglicher Assoziationsfaktor untersucht.
Es wurden die Daten von 1.523 Siebtklässlerinnen und Siebtklässlern ausgewertet, die eine von 47 an der Studie teilnehmenden Berliner Schulen besuchten. Die Schüler beantworteten einen Fragebogen zu verschiedenen Themenbereichen wie Soziodemographie, Gesundheitsstatus, Rauchverhalten, Alkoholkonsum, körperliche Aktivität, Bildschirmzeit und anderen. Mittels Regressionsanalysen wurden Assoziationen der erfassten Variablen mit körperlicher Aktivität (WHO-Kriterien von 60 Minuten moderater Aktivität pro Tag erfüllt) und Bildschirmzeit (über 2 Stunden am Tag) untersucht.
Die Analysen bestätigten, dass das männliche Geschlecht und ein niedrigerer BMI positiv mit körperlicher Aktivität assoziiert waren. Ein niedriger Sozialindex war ebenfalls positiv assoziiert, der Sozialindex der Schulen jedoch nicht. Auch der individuelle sozioökonomische Status war in unserer Studie nicht mit körperlicher Aktivität assoziiert. Es zeigte sich weiter,

dass Schüler der Integrierten Sekundarschulen häufiger die Empfehlungen zu körperlicher Aktivität erfüllten als die Gymnasiasten.
Die Empfehlung, nicht mehr als 2 Stunden pro Tag (außerhalb der Schule) vor dem Bildschirm zu verbringen, erfüllten mehr Mädchen sowie Jugendliche mit niedrigerem BMI. Im Gegensatz zu körperlicher Aktivität, war Bildschirmzeit mit dem individuellen sozioökonomischen Status assoziiert. Je niedriger der Status, desto wahrscheinlicher verbrachten die Schüler mehr als 2 Stunden vor dem Bildschirm. Auch ein niedriger Sozialindex und der Schultyp (Integrierte Sekundarschule) war mit mehr Bildschirmzeit assoziiert. Für den Sozialindex der Schulen konnte keine Assoziation gezeigt werden.

BMJ Open

Association of individual and neighbourhood socioeconomic status with physical activity and screen time in seventh-grade boys and girls in Berlin, Germany: a cross-sectional study

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ABSTRACT

Objectives Few studies have explored the impact of neighbourhood socioeconomic status (SES) on health behaviours in youths in Germany. Our aim was to investigate the association of individual and neighbourhood SES with physical activity (PA) and screen time (ST) in students aged 12–13 years in Berlin.

Design Cross-sectional study.

Setting Secondary schools (high schools and integrated secondary schools) in Berlin, Germany.

Participants A total of 2586 students aged 12–13 years (seventh grade).

Main outcome measures Sociodemographics, anthropometric data and health behaviours were assessed by self-report during classes. Primary outcome was the association of individual and neighbourhood SES with meeting daily PA and exceeding daily ST recommendations. Students' characteristics were described with means or percentages. Comparisons were performed using generalised linear mixed model yielding ORs with 95% CIs.

Results Mean (±SD) age was 12.5±0.5 years, 50.5% were girls and 34.1% had a migrant background. When adjusting for individual covariates, associations of low versus high individual SES were 0.85 (0.48; 1.52) for PA and 2.08 (1.26; 3.43) for ST. Associations of low versus high neighbourhood SES were 1.76 (1.12; 2.75) for PA and 1.54 (1.10; 2.17) for ST. After additional adjustment for school type and school neighbourhood SES, associations comparing low versus high individual and neighbourhood SES were attenuated for PA (individual SES 0.74 (0.41; 1.33) and neighbourhood SES 1.51 (0.93; 2.46)) and ST (individual SES 1.88 (1.12; 3.14) and neighbourhood SES 1.40(0.98; 2.00).

Conclusions Lower individual and neighbourhood SES were associated with higher ST. Lower neighbourhood but not individual SES was associated with higher PA. After consideration of school type and school neighbourhood SES associations were attenuated and became insignificant for the relationship between neighbourhood SES, PA and ST. Further research is warranted to unravel the complex relationships between individual SES, neighbourhood SES and school environment to develop more targeted health promotion strategies in the future.

Strengths and limitations of this study

- This study provides important new insights into the association of individual and neighbourhood socioeconomic status (SES) with physical activity (PA) and screen time (ST) among seventh grade boys and girls attending secondary schools in Berlin, Germany.
- The study comprises a large sample with students recruited from all 12 districts of Berlin, including a variety of neighbourhoods with different levels of SES.
- PA was not assessed objectively but via self-report and only ST was assessed, while other types of sedentary behaviours were not taken into account.

INTRODUCTION

Physical activity (PA) as well as sedentary behaviour have an important impact on health and well-being.[1] Low levels of PA are associated with higher health risks already among children and adolescents[2] and an increasing number of studies have identified sedentary behaviour as an independent risk factor for diseases such as diabetes and obesity in children and adolescents.[3]

In the last decades, however, sedentary behaviour among children and adolescents is increasing while the rates of children being active appear to be decreasing over time.[4–7] In addition, longitudinal studies have shown a decline in PA and at the same time an increase in sedentary behaviour among children and adolescents with increasing age.[8–10] Screen time (ST) (time spent watching TV or

playing games on the computer or playing video games) is one important aspect of sedentary behaviour, even though it does not encompass the total time spent being sedentary.[11]

While there is evidence of an association of age and sex with PA,[12] studies exploring the influence of socioeconomic status (SES) and built and social environment of children show heterogeneous results.[13–16]

A low individual SES is often associated with a higher body mass index (BMI) and more sedentary time, but not always with low PA.[17–19] In addition to individual SES, studies investigating the social environment (ie, social support and social networks, socioeconomic position and income inequality, racial discrimination, social cohesion and social capital) of children found evidence of an association with PA and diet.[20–22] The built environment has also been shown to be associated with PA among children and youth.[23]

Another aspect of the social environment is the neighbourhood SES. Studies investigating the influence of neighbourhood SES on health showed an association of disadvantaged neighbourhoods with worse health status[24] or a higher risk for cardiovascular diseases.[25] Mechanisms through which a lower neighbourhood SES may influence PA and sedentary behaviour could be reduced municipal services such as recreational facilities and playgrounds, financial stress or less possibilities to own a gym membership.[22] Also, a higher crime rate may lead to less activities outside.[26] With regard to these associations between PA, sedentary behaviour and the neighbourhood SES, study results are heterogeneous ranging from no association to a clear association.[27–30] Other studies in turn found that the neighbourhood SES was only a positive modifier for the association of environmental factors with PA and sedentary behaviour.[31 32] Knowing more about independent associations of individual and neighbourhood SES could help to address groups of adolescents in a more targeted way when implementing prevention strategies (eg, adapting the content of health promotion strategies to different neighbourhoods).

Our aim was therefore to investigate the association of individual and neighbourhood SES with PA and ST as one important form of sedentary behaviour in a population-based sample of boys and girls aged 12–13 years attending secondary schools in Berlin, Germany.

METHODS

Study design and setting

The present cross-sectional analysis is part of the BEST-prevention study, a three-armed cluster randomised controlled trial that was conducted from 2010 to 2014 (baseline assessment was conducted from 2010 to 2011) with the aim to evaluate a parent involving smoking prevention programme for seventh grade students in Berlin.[33] Here, we report cross-sectional data regarding PA and ST among the students at baseline including associations with individual and neighbourhood SES.

Participants and recruitment

Details of the recruitment are described elsewhere.[34] Briefly, prior to recruitment, permission of the Berlin senate of education, youth and research (Senatsverwaltung für Bildung, Jugend und Wissenschaft) was obtained, and school principals and contact teachers from all 12 districts of Berlin were informed about the project. Students were eligible for the study if they: (1) were in the seventh grade, (2) attended one of the participating schools and (3) showed intellectual and physical ability to make an informed decision about study participation. Separate signed written informed consent was required from participating students as well as from at least one parent/caregiver. The study was approved by the ethical review committee of the Charité-Universitätsmedizin Berlin, Germany.

Measurements

The study questionnaire is based on existing and validated questionnaires investigating adolescent health behaviour (eg, Health Behaviour in School-Aged Children, HBSC[35]; German Children and Youths Survey, KIGGS).[36] It includes questions related to sociodemographics, smoking and other health behaviours, such as alcohol consumption, nutrition, PA and ST, as well as height and weight. It took about 30–40 min to complete the questionnaire. Our study group has the status of an associated project of the HBSC.

During a first visit to schools, the BEST study was presented to the students by trained research personnel and consent forms were distributed for students and parents/caregivers. During the second visit, which took place a few weeks later, baseline data were assessed with the questionnaire in the classroom among children, who had provided both consent forms.

Outcome measures

Physical activity

PA was assessed using two adapted items of the HBSC questionnaire. The first question read: 'On how many days in the past week were you physically active for at least 60 min?' According to WHO guidelines, for our primary outcome we defined a student as meeting current guidelines if he or she was active at least 60 min on each of the last 7 days (yes/no).[37] The other question asked for the number of hours of moderate intensity PA per week ('How many hours per week are you physically active (any activity that increases your heart rate and makes you get out of breath)?') with examples of such activities. This number was divided by seven to obtain the number of hours of PA per day.

Screen time

ST was assessed with two questions (also part of the HBSC questionnaire) asking for the time spent each day watching TV or playing with the computer. TV time was assessed by asking 'How many hours/day do you usually watch television in your free time?' for weekdays and weekend days separately. Computer time (minutes/day) was assessed by asking 'How many hours/day do you usually play games on

a computer, or use a game console in your leisure time?'. Total ST was computed by adding up TV and computer time. Using a smartphone or tablet was not assessed. According to the AAP[38] recommendations, we defined more than 2 hours of ST per day as high ST.

Covariates

Individual level

Sex, age and anthropometric data (height and weight) of the students were assessed via self-report. The BMI was calculated using the self-reported data. BMI categories are presented using cut-offs defined by the specific percentiles which at age 18 years correspond to the adult cut-off points for underweight (<18.5 kg/m^2), overweight (25 kg/m^2) and obesity (30 kg/m^2). According to that definition, underweight is defined as a BMI <10th percentile, normal weight as a BMI between the 10th and the 90th percentile, overweight as a BMI between the 90th and the 97th percentile and obesity as a BMI ≥97th percentile.[39 40]

According to official definitions, a student was defined as having a migration background if he or she was not born in Germany or if at least one parent was not born in Germany but moved to Germany after 1949.[41]

Individual SES

To assess the individual SES of the student, we used the Family Affluence Scale (FAS), a validated instrument to assess the material affluence of the family asking for the number of cars and computers in the family, for holidays during the past 12 months, and whether the child has its own room.[42] The FAS consists of values from 0 to 7, with higher values indicating higher affluence, and can be categorised into three categories (low (0–3), moderate (4-5) and high affluence (6-7). The FAS was completely assessed only at the 24 months follow-up, we therefore used the 24 months follow-up FAS to describe family SES at baseline.

Neighbourhood SES

For the SES of the students' neighbourhood, we used the social index defined and implemented by the 'Atlas of Social Structure' (Sozialstrukturatlas). It is an instrument used in Berlin to describe the social situation of Berlin by classifying 447 subareas (with on average 7500 habitants) of the 12 districts of Berlin accordingly.[43 44] This social index reflects the distribution of social and health burden in Berlin. Social and health indicators are, for example, unemployment, welfare reception rate, average per capita income and also premature mortality and avoidable deaths. The index ranges from 1 reflecting the best to 7 reflecting the worst social situation of a district.

School types

In Berlin, two types of secondary schools exist: high schools with the possibility to achieve a high school diploma after 12 years, as well as integrated secondary schools (an integration of different school types) with the possibility to achieve a high school diploma after 13 years. More often than high schools, integrated secondary schools are left by the students after the 10th grade with a secondary school leaving certificate. The academic requirements are higher in high schools than in integrated secondary schools.[45]

School neighbourhood SES

Since the neighbourhood of the school can be different to that of students, we assessed this information (analogous to the individual neighbourhood SES) in order to take an additional influencing factor of the students' behaviour into account.

Statistical analysis

All statistical analyses were performed for the students aged 12 and 13 years due to the small number of students younger than 12 and older than 13 years (8.1%). We used all data available for the respective analysis; missing data were not imputed.

Characteristics of schools and students were analysed by descriptive statistical methods (eg, mean and SD, frequencies and percentages; P values are derived from t-tests and χ^2tests).

Because of the nested structure of the data with both fixed and random effects, a generalised linear mixed model with a logit link function was used for the analysis when comparing groups (models with random intercept). In general, the random factors 'school' and 'class within school' (as nested factor) were included into the models, with either PA or ST as the dependent variable. Results are presented as ORs and 95% CIs.

These models were used to determine the association of several factors. For PA as the dependent variable, sex, migration background, BMI and ST were included into all models, in addition with individual SES (FAS-score) (model 1) or students' neighbourhood SES (model 2) or both (model 3a). A final model included the aforementioned plus the two school level variables school type and school neighbourhood (model 3b). The same procedure was performed for ST as the dependent variable, respectively. To be able to compare different models, the analyses were restricted to the number of students with non-missing data for the model with the largest number of variables included. As sensitivity analyses, to assess if associations are modified by gender, interaction effects on gender were included into the models. Additional sensitivity analyses were performed based on the maximum number of students with non-missing data for the respective model. All P values are considered exploratory (with no adjustment for multiple testing). Analyses were performed using the software package SAS release V.9.3 and V.9.4 (SAS Institute).

RESULTS

Characteristics of the study population

Out of 214 contacted schools, 49 schools (23%; 4291 students) showed interest and were eligible for study participation. Before baseline assessment, 1268 out of these 4291

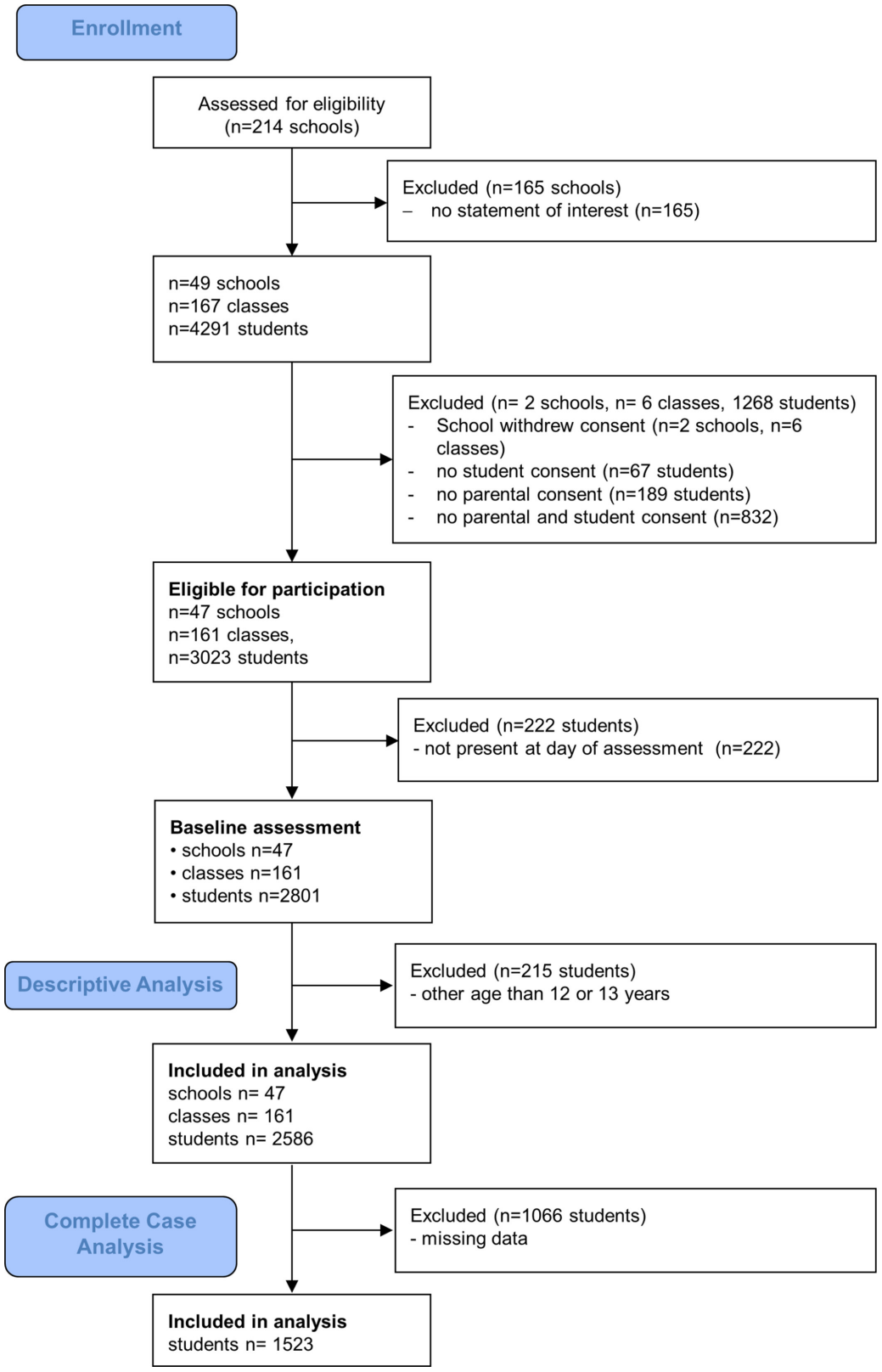

Figure 1 Flow chart of the recruitment process.

students dropped out including two entire schools. Two thousand, eight hundred and one students participated at the baseline assessment. Out of those, we included 2586 students aged 12 and 13 years in our descriptive analyses and 1523 in our complete case analyses. Figure 1 shows the recruitment process of the schools, classes and students.

Sociodemographic characteristics of all participating students are presented in table 1a. The mean (±SD) age

Table 1a Characteristics of the study sample

Individual level	Boys	Girls	Total	P value
	Mean±SD or n (%)			
No of students, n (%)	1279 (49.5)	1307 (50.5)	2586	
Age (years, mean±SD) (n=2586)	12.5±0.5	12.4±0.5	12.4±0.5	<0.001
12 years, n (%)	651 (50.9)	775 (59.3)	1426 (55.1)	<0.001
13 years, n (%)	628 (49.1)	532 (40.7)	1160 (44.9)	
Height (cm, mean±SD) (n=2440)	161.1±9.5	160.1±7.3	160.6±8.4	0.003
Weight (kg, mean±SD) (n=2360)	49.5±10.9	47.0±8.9	48.3±10.0	<0.001
BMI* (kg/m^2, mean±SD) (n=2296)	18.9±3.1	18.3±2.7	18.6±2.9	<0.001
BMI range	11.8–30.9	11.7–33.8	11.7–33.8	
Underweight (BMI <10th percentile)†	126 (11.1)	218 (18.8)	344 (15.0)	<0.001
Normal weight (BMI 10th to <90th percentile)†	822 (72.2)	843 (72.6)	1665 (72.4)	
Overweight (BMI 90th to <97th percentile)†	166 (14.6)	90 (7.8)	256 (11.1)	
Obesity (BMI ≥97th percentile)†	24 (2.1)	10 (0.9)	34 (1.5)	
Migrant background (n=2423)	396 (33.1)	429 (35.0)	825 (34.0)	0.307
Individual SES (Family Affluence Scale; FAS) (n=2139)				
High (FAS 6–7)	569 (53.7)	500 (46.3)	1069 (50.0)	0.003
Moderate (FAS 4–5)	371 (35.0)	441 (40.9)	812 (38.0)	
Low (FAS 0–3)	120 (11.3)	138 (12.8)	258 (12.1)	
Students' neighbourhood SES (n=2240)	1114	1126	2240	
Mean±SD	4.0±1.9	4.1±1.9	4.0±1.9	0.526
1 (best)	127 (11.4)	123 (10.9)	250 (11.2)	
2	182 (16.3)	194 (17.2)	376 (16.8)	
3	143 (12.8)	119 (10.6)	262 (11.7)	
4	215 (19.3)	229 (20.3)	444 (19.8)	
5	162 (14.5)	160 (14.2)	322 (14.4)	
6	134 (12.0)	134 (11.9)	268 (12.0)	
7 (worst)	151 (13.6)	167 (14.8)	318 (14.2)	
School type (n=2586)				
High school‡ students (15 schools)	507 (39.6)	624 (47.7)	1131 (43.7)	<0.001
Integrated secondary school§ students (32 schools)	772 (60.4)	683 (52.3)	1455 (56.3)	

Descriptive statistical methods.
*Body mass index (kg/m^2).
†BMI percentiles according to Cole *et al*.[39 40]
‡High schools (5th or 7th grade to 12th grade, graduation with high school diploma after 12th grade).
§Integrated secondary schools (integration of different school types, 7th grade to 13th grade, graduation with secondary school leaving certificate after 10th grade or high school diploma after 13th grade).
SES, socioeconomic status.

of participants was 12.4±0.5 years (12.5±0.5 for boys and 12.4±0.5 for girls) and the distribution between girls and boys was similar (50.5% vs 49.5%). Of the entire sample, 34.1% were defined as having a migrant background. Boys reported more often a high individual SES than girls (53.7% vs 46.3%). Mean neighbourhood SES was similar among boys and girls (4.0±1.9 and 4.1±1.9). Individual and neighbourhood SES were moderately correlated (Spearman's rank correlation coefficient=0.36; P<0.001). School characteristics are presented in table 1b. An association between the students' neighbourhood SES and the school type could be observed, indicating that the mean students' neighbourhood SES was higher among high school students than integrated secondary school students.

Of the total sample, 12.8% fulfilled WHO criteria of being active for at least 60 min per day. The proportion of boys fulfilling the criteria was higher than in girls (15.9% of the boys vs 9.8% of the girls, OR 1.7 (1.4; 2.2); P<0.001) and boys also spent more time being active than girls (0.9±0.8 vs 0.6±0.6 hours per day, mean difference 0.3 hours (0.2; 0.3), P<0.001). 81.5% of the boys and 66.9% of the girls reported more than 2 hours ST per day, OR 2.2 (1.8; 2.6); P<0.001. Average ST was also

Table 1b Characteristics of schools

School level	High schools*	Integrated secondary schools†	Total	P value
School neighbourhood SES, Mean±SD (n=47)	3.5±1.4	4.4±1.9	4.0±1.8	<0.001
n (%)				
1 (best)	1 (6.7)	3 (9.4)	4 (8.5)	
2	4 (26.7)	3 (9.4)	7 (14.9)	
3	2 (13.3)	4 (12.5)	6 (12.8)	
4	4 (26.7)	7 (21.9)	11 (23.4)	
5	2 (13.3)	4 (12.5)	6 (12.8)	
6	2 (13.3)	5 (15.6)	6 (12.8)	
7 (worst)	0 (0.0)	6 (18.8)	6 (12.8)	
Students' neighbourhood SES*, mean±SD (n=2240)	3.1±1.6	4.6±1.9		<0.001
Individual SES* (Family Affluence Scale; FAS) (n=2139)				
n (%)				
High (FAS 6–7)	744 (65.8)	531 (36.5)		<0.001
Moderate (FAS 4–5)	338 (29.9)	652 (44.8)		
Low (FAS 0–3)	49 (4.3)	272 (18.7)		

Descriptive statistical methods.
*High schools (5th or 7th grade to 12th grade, graduation with high school diploma after 12th grade).
†Integrated secondary schools (integration of different school types, 7th grade to 13th grade, graduation with secondary school leaving certificate after 10th grade or high school diploma after 13th grade).
SES, socioeconomic status.

higher among boys than among girls (3.9±2.7 hours vs 3.1±2.5 hours); P<0.001 on week days and 6.5±3.6 hours vs 4.9±3.4 hours on weekend days.

Association of individual and neighbourhood SES with PA and ST

Results of multivariable analyses are presented in figures 2 and 3. These results presented in figures 2 and 3 and in (online supplementary tables 1 and 2 are based on an identical analysis population with complete information (n=1523). Results for the multivariable analysis not restricted to complete cases are additionally presented in online supplementary tables 3 and 4). The results did not differ markedly between both approaches.

In multivariable analyses, individual SES was not associated with PA. The ORs after adjustment for individual factors were 0.90 (0.63; 1.29) and 0.85 (0.48; 1.52); P=0.792 for middle and low SES, respectively, compared with high SES. Additional adjustment for school type and school neighbourhood SES did not change the results notably (0.83 (0.58; 1.20) and 0.74 (0.41; 1.33); P=0.476). ST in contrast was associated with individual SES. The lower the students' SES the higher the odds to spent more than 2 hours of ST per day (1.31 (1.00; 1.72) and 2.08 (1.26; 3.43); P=0.008) for middle and low individual SES, respectively, compared with high SES. This association was attenuated slightly when additionally adjusting for school variables (1.25 (0.95; 1.64) and 1.88 (1.12; 3.14); P=0.036).

In contrast to individual SES, a lower neighbourhood SES was associated with a higher odds of engaging in 60 min per day in PA (1.34 (0.86; 2.08) and 1.76 (1.12; 2.75); P=0.047) for middle and low neighbourhood SES, respectively, compared with high neighbourhood SES after adjustment for individual factors; after adjustment for school variables, the association of neighbourhood SES with PA was attenuated somewhat and no longer independently associated (OR 1.19 (0.78; 1.82) and 1.51 (0.93; 2.46); P=0.253).

Compared with high neighbourhood SES, students with low neighbourhood SES were more likely to spend more than 2 hours of ST per day (OR 1.54 (1.10; 2.17)), while there was no association for students with middle neighbourhood SES (1.03 (0.75; 1.41); P=0.019). When additionally adjusting for school variables, neighbourhood SES was no longer independently associated with ST and the OR of middle and low neighbourhood SES, compared with high neighbourhood SES, became almost equal (1.37 (0.99; 1.91) and 1.40 (0.98; 2.00); P=0.109). There was no interaction effect between gender and ST regarding PA, nor between gender and PA regarding ST (data not shown).

DISCUSSION

In this study, we investigated the association of individual and neighbourhood SES with PA and ST among seventh grade school students. The individual SES of

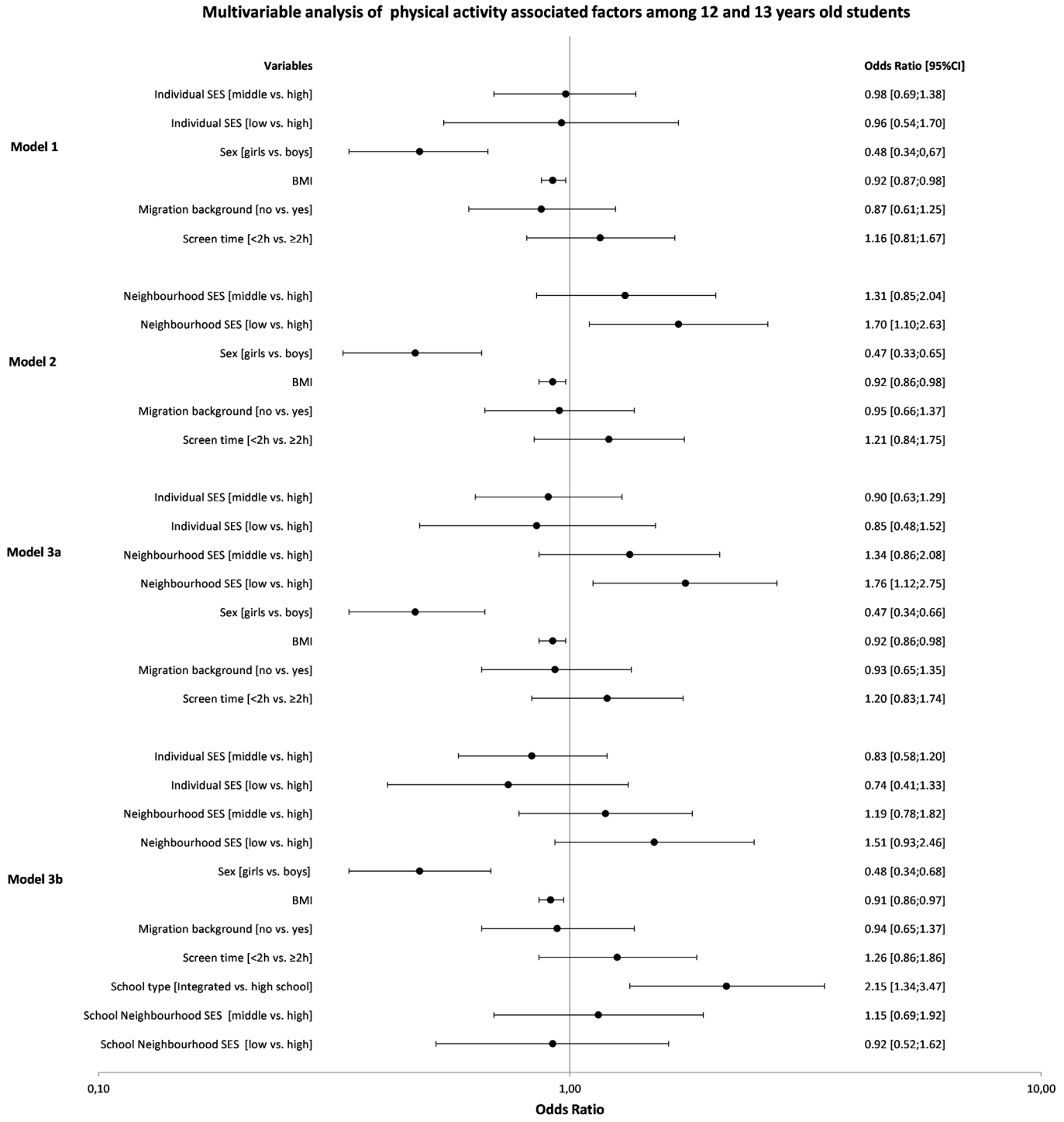

Figure 2 Multivariable analysis of physical activity-associated factors among students aged 12–13 years (complete case analysis, n=1523). BMI, body mass index; SES, socioeconomic status.

the students in our study sample, measured with the FAS, was significantly associated with ST. Students with lower SES were more likely to spend more than 2 hours per day viewing screen devices. Compared with high SES, low SES was more strongly associated with ST than middle SES. Similar results were found in other studies.[16 46 47] Potential reasons for these findings are that parents with better education and higher statuses may be more aware of the health consequences of excessive ST and thus have stricter rules regarding ST behaviour.[48] Children from families with lower SES may also more often have a TV in their room, which has been shown to be associated with higher ST levels.[49] Moreover, it is well known that parents have an important role-modelling function, which influences children's behaviours, such as screen viewing.[50] Since children of families with lower SES may more often have parents that engage in higher ST and/or watch more often TV

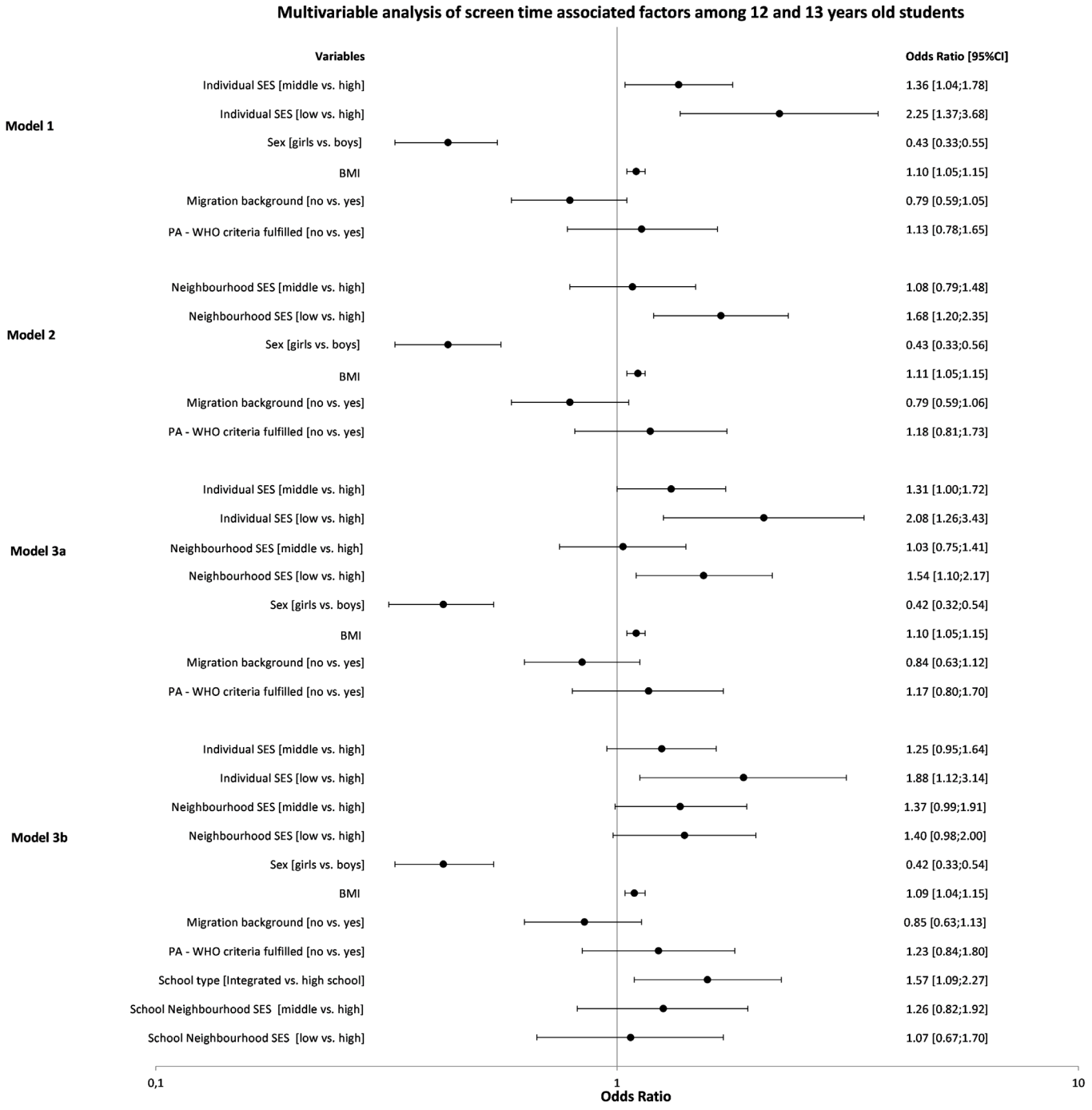

Figure 3 Multivariable analysis of screen time associated factors among students aged 12–13 years (complete case analysis, n=1523). BMI, body mass index; PA, physical activity; SES, socioeconomic status.

together with their parents, they may in turn engage in more ST.[51]

PA on the other hand was not associated with individual SES in our study population. This finding is in part consistent with the results of the HBSC study for Germany and with a few other studies.[8 52 53] A possible explanation for this finding is that PA consists not only of organised sports or activities that require a club membership or sports equipment. On the contrary, a large part of PA among youths may be daily life activities, such as active commuting, or sports and activities in the neighbourhood and in parks which is independent from the individual SES.[54] However, in contrast to our findings and the other studies, a variety of studies do show an association between SES and PA, which has been highlighted in reviews by Hanson and Chen or Sallis *et al*.[16 55] It should be noted that most of these studies are from the USA or Australia and the explanations for the observed associations, such as the higher prevalence of unsafe neighbourhoods or of neighbourhoods with less green space may not be directly transferable to Germany and Berlin.

The other main aspect of our study was the investigation of the neighbourhood SES and its association with PA and ST.

The neighbourhood SES represents the social and health indicators of a city or of its districts, including unemployment rate, welfare reception rate, average per capita income and others. In our study, students living in low SES neighbourhood areas were more likely to be physically active than those with middle or high neighbourhood SES. To a certain extent, this is surprising and in contrast to many earlier studies that have reported mostly no or inverse associations between neighbourhood SES and PA.[28 56–59] However, as suggested in an earlier study the observed finding in our study may be related to higher active transportation among adolescents of families with lower SES because they may be less likely to own a car resulting in more students using the bicycle or public transportation to school.[60] Similar to individual SES, another explication could be that the major part of PA among adolescents consists of unstructured activities rather than organised team sports.[54] Thus, a membership in a sports club (which is less probable in neighbourhoods with lower SES) would not affect the overall amount of PA.

Low and middle neighbourhood SES were also associated with higher ST compared with high neighbourhood SES. This result is in line with a study by Carson *et al*.[61] Neighbourhood safety, as suggested by Carson *et al*, may be one possible explanation for this finding. In addition, the lack of suitable and well-maintained recreation facilities could lead to more ST as replacement of other leisure time activities. In contrast to our results, many studies investigating neighbourhood SES and its association with sedentary behaviour reported null results as shown in a recent review by Stierlin *et al*, suggesting that other factors may be more important than neighbourhood SES in the context of adolescents' sedentary behaviour.[30] Possible reasons for these differences between findings may be related to different study populations across individual studies but also the fact that our study only focused on ST instead of total sedentary behaviour. Screen viewing as a health behaviour has not been investigated widely in the context of individual and neighbourhood SES, but it appears that in Berlin it is more closely linked with these factors than PA. Hence, promoting alternative activity opportunities for adolescents living in lower SES neighbourhoods could be a worthwhile target for interventions. In the context of the existing literature, it would be useful to also investigate total sedentary behaviour in future German studies.

In addition to individual and neighbourhood SES, school level factors play a role in the health behaviour of school children.[62] Moore and Littlecott found that school level affluence was independently associated with health behaviours (except PA) of the school students after adjusting for the individual SES.[63] When additionally including school type and school neighbourhood SES as covariates in our analysis, presented results for PA and ST were attenuated somewhat and neighbourhood SES was no longer independently associated with PA and ST, indicating the potentially important role of school type and school neighbourhood SES on PA and ST.

A possible explanation for this finding could be that adolescents living in areas with lower neighbourhood SES are more often attending an integrated secondary school which has been shown in table 1b. Since the academic standards of integrated secondary schools tend to be lower than those of high schools, it is possible that students of the first-mentioned have more leisure time than those of the latter.[64 65]

Some studies found that the school socioeconomic environment, that is, social networks and peer influences had a greater effect on health behaviour among adolescents than the individual SES.[63 66] This illustrates the complex interplay of individual SES, neighbourhood SES and the school environment (school type and school neighbourhood SES), that may also be affected by parental choice of schools and other parental influences on school activities.[67] A recent study from the UK has provided some further evidence for these complex relationships.[63] Studies from Germany have also shown that the neighbourhood SES as well as the SES of the students tends to be correlated with the school type.[68] Better educated parents tend to send their children to high schools rather than integrated secondary schools,[69] which could imply that it is the school type itself influencing PA and ST, and the social environment of the student. But even if the choice of the school type is done by the parents and is influenced by their SES, targeting integrated secondary schools may be important and could be emphasised more in health promotion activities. It appears that this may help to address the issue of individual SES on the one hand (more children with low SES in secondary schools) but also neighbourhood SES on the other hand. Further research is needed to disentangle these complex relationships between individual and neighbourhood SES, as well as school environment. With additional research it could be investigated if some neighbourhoods might benefit more from ST-related activities, while others might benefit more from PA-related activities. The aim should be the ability to target the content of health promotion activities according to school type and neighbourhood to meet greatest needs.

In addition to individual and neighbourhood SES, other factors like the built environment (ie, number of public transport stops, residential density, intersection density and the number of parks) could also play an important role in adolescents' health behaviours.[70] These factors may be mediators of the observed associations, but studies have also suggested that associations may be moderated by the built environment (studies have shown that individuals with low neighbourhood SES had a greater benefit of good walkability than those with a high neighbourhood SES).[31 32] Future research should therefore also include measurements of the built environment in Berlin to provide new insights into the associations with PA.

Strengths and limitations

Strengths of our study include the size of our sample, as well as the proportion of students with migration background,

SES and gender distribution, which appear to be very similar to the student population of Berlin.[71] However, the results are only valid for regions with similar characteristics as Berlin: an urban well-connected region with relatively safe neighbourhoods and good infrastructure for transportation and cycling.

Some limitations have to be considered as well. First, FAS was only assessed at the 24-month follow-up. However, we assessed one item of the FAS (holiday) additionally at baseline and at the 12-month follow-up. The answers were quite similar over the 2 years. We thus think that the period of 2 years was not associated with major changes in the FAS level. We also found differences in the self-report FAS of boys and girls, which is somewhat surprising. It is possible that the structure of the questionnaire led to an overestimation among boys due to a higher interest in cars and computers (ie, two key elements of the FAS). Second, PA was not measured objectively. Self-report of children and adolescents, especially regarding PA, may lead to biased results through misreporting.[72] Measurement errors associated with self-report may further be influenced by SES of adolescents.[73] Future studies should use accelerometers or other means to objectively measure PA and sedentary behaviour.[74] Another limitation of our study is that we did not assess total sedentary behaviour and that ST was determined based on the use of TV, computer and video games as assessed by the HBSC questionnaire.[35 75] Other increasingly popular screen devices (eg, smartphones, tablets) and other kinds of sedentary behaviours like sitting during homework, talking on the phone and sitting at school were not taken into account, which may have led to an underestimation of ST.

CONCLUSION

Lower individual and neighbourhood SES were associated with higher ST. Lower neighbourhood but not individual SES was associated with higher PA. After consideration of school type and school neighbourhood SES associations were attenuated and became insignificant for the relationship between neighbourhood SES, PA and ST. Further research is warranted to unravel the complex relationships between individual SES, neighbourhood SES and school environment to develop more targeted health promotion strategies in the future.

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Contributors LK and FM-R drafted the manuscript with intellectual input from SR, NR, JM-N and NS-B. FM-R supervised the study and LK carried out the data collection and parts of the data analysis. FL and SR were responsible for data assessment and statistical analyses, FM-R, CB, NR, JM-N and NS-B were responsible for the design of the recruitment methods and the assessment tools, FM-R, NR, JM-N and SNW conceptualised the study. All authors read and approved the final manuscript.

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2.1.2. Determinanten von körperlicher Aktivität und Bildschirmzeit bei Berliner Jugendlichen – Längsschnittanalyse

***Krist, L.**, Roll, S., Stroebele-Benschop, N., Rieckmann, N., Müller-Nordhorn, J., Bürger, C., Willich, S.N., Müller-Riemenschneider, F.:* Determinants of Physical Activity and Screen Time Trajectories in 7th to 9th Grade Adolescents - A Longitudinal Study. *Int J Environ Res Public Health. 2020;17(4).*

Die durchschnittliche tägliche körperliche Aktivität nimmt vom Kindes- zum Jugendalter kontinuierlich ab, während die Dauer, die im Sitzen verbracht wird, z.B. als Bildschirmzeit, zunimmt. Diese allgemeinen Ergebnisse lassen allerdings keine Aussage über mögliche Subgruppen zu, die dem oben erwähnten Muster nicht folgen. Das Ziel dieser Studie war es daher, über 2 Jahre Verläufe von körperlicher Aktivität und Bildschirmzeit bei Siebtklässlern zu beobachten und individuelle sowie schulbezogene Determinanten für diese Verläufe zu analysieren.

Dauer und Häufigkeit von körperlicher Aktivität sowie Bildschirmzeit wurden zu drei Zeitpunkten bei einer Kohorte von Berliner Schülern der 7. Klassenstufe (Gymnasium und Integrierte Sekundarschule) über 2 Jahre (jährliche Follow-Ups in 8. und 9. Klasse) mittels eines Selbstausfüller-Fragebogens erhoben, um die verschiedenen Verläufe von körperlicher Aktivität und Bildschirmzeit zu beschreiben (steigend, abnehmend, gleichbleibend hoch oder gleichbleibend niedrig). Mittels multivariabler Regressionsanalysen wurden dann Prädiktoren für den jeweils positiven Verlauf untersucht.

Es nahmen 2.122 Schüler an allen drei Erhebungszeitpunkten teil. Die Ergebnisse der Studie zeigten eine Reduktion der durchschnittlichen körperlichen Aktivität und einen Anstieg der Bildschirmzeit. Beim 2. Follow-Up erfüllten die Schüler seltener als zu Baseline die Empfehlungen zu körperlicher Aktivität (mind. 60 Minuten pro Tag) (9,4% vs. 13,2%) und Bildschirmzeit (max. 2 Stunden täglich außerhalb der Schule) (19,4% vs. 25,0%). Männliches Geschlecht war der einzige Prädiktor für einen gleichbleibend hohen oder steigenden körperlichen Aktivitätsverlauf über 2 Jahre. Dagegen waren für eine gleichbleibend niedrige oder reduzierte Bildschirmzeit über die 2 Jahre Follow-Up weibliches Geschlecht, hoher sozioökonomischer Status und Gymnasialangehörigkeit unabhängig voneinander Prädiktoren.

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Determinants of Physical Activity and Screen Time Trajectories in 7th to 9th Grade Adolescents—A Longitudinal Study

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Abstract: Physical activity (PA) in youth tends to decline with increasing age, while sedentary behaviour including screen time (ST) increases. There are adolescents, however, whose PA and ST do not follow this pattern. The aim of this study is (i) to examine trajectories in PA and ST from grade 7–9 among students in Berlin, and (ii) to investigate the relationship of these trajectories with individual factors and school type. For the present analyses, changes in students' PA and ST across three time points from 7th to 9th grade were assessed via self-report questionnaires. Positive and negative trajectories were defined for both PA (positive: increasing or consistently high, negative: decreasing or consistently low) and ST (vice versa). Multivariable logistic regression analyses were performed to identify possible predictors of PA and ST trajectories. In total, 2122 students were included (50.2% girls, mean age 12.5 (standard deviation 0.7) years). Compared to grade 7, less students of grade 9 fulfilled PA and ST recommendations (PA: 9.4% vs. 13.2%; ST: 19.4% vs. 25.0%). The positive PA trajectory included 44% of all students (63% boys), while the positive ST trajectory included 21% of all students (30% boys). Being a boy was significantly associated with a positive PA trajectory, while being a girl, having a high socioeconomic status, and attending a high school, were significantly associated with a positive ST trajectory. Different PA and ST trajectories among adolescents should be taken into account when implementing prevention programs for this target group.

Keywords: physical activity; screen time; trajectory; school students; adolescents; longitudinal

1. Introduction

The decline in adolescents' physical activity (PA) and the increase of screen-based sedentary behaviour (screen time; ST) is an important public health concern [1]. While physical activity has a

large number of positive effects on physical and psychological health, screen time is associated with an increased risk for cardiovascular and metabolic diseases as well as numerous psychological disorders like depression, low self-esteem, and psychological distress [2–6].

Health behaviours that develop during adolescence can have enduring effects on health behaviours in adult life [7,8]. Movement guidelines for children and adolescents recommend at least 60 min per day of moderate-to-vigorous physical activity (MVPA) and not more than 2 h of recreational screen time per day [9–12]. The German Children and Youths Survey (KIGGS Wave 1, 2009–2012) reported higher PA at age 11–13 years compared to age 14–17 years (12% compared to 8% of the girls and 17.4% compared to 15% of the boys fulfilled WHO recommendations, respectively) [13]. The German "Health Behaviour in School-aged Children" (HBSC) study (2002–2010) showed higher screen time in adolescents aged 15 years compared to 11 years: 68% compared to 42% of the girls and 67% compared to 50% of the boys, respectively, are spending more than two hours per day on screen time behaviour [14,15].

Evidence from longitudinal studies shows a decline in physical activity and an increase in sedentary behaviour (SB) from childhood through adolescence [8,16–22]. However, only few longitudinal studies among German adolescents are available. Schwarzfischer et al. reported the longitudinal development of PA and SB at three time points (2008, 2010, and 2013) and associations with BMI and body fat, however, Germany was only one of five European countries included in this study and the measurement of PA was not the study's main purpose [22]. Braig et al. reported associations of PA and ST with self-esteem in 11–13 year old adolescents in a very selective sample in a small city in southern Germany [3]. Most studies describe socioeconomic status, anthropometric measures, education of parents, and migration background as factors associated with PA and ST [3,23,24]. While high socioeconomic status and high educational levels are mostly associated with high PA and low ST, migration background is more often associated with lower PA and higher ST [25,26]. Regarding school type, no longitudinal studies are available for Germany, but two cross-sectional studies report an association of lower school type with higher screen time behaviour (consumption of TV and computer/gaming consoles) [27,28].

Whereas associated factors are mostly reported for the whole study sample representing average changes of the sample (based on mean differences normally assessed at two time points), this approach does not investigate distinct subgroups following different trajectories of PA and ST [18]. There is growing evidence that health behaviour of children and adolescents is easier understood by taking a deeper look into different subgroups following unique patterns of behaviour change. A recent systematic review of 2019 reported results of 11 studies investigating PA trajectories in a young age group performing descriptive analyses of the emerged trajectories and investigating associations with various predictors and/or determinants (e.g., health behaviour, urban vs. rural dwelling, or parental education) [29]. While trajectory modelling analyses require multiple measurements over a long study period, there are on the other hand studies investigating trajectories with only two assessment points. Two studies (both using predefined trajectories) found associations of built environment, social support, well-being, and parental education with PA trajectories, however, no information about ST trajectories was reported [30,31].

To our knowledge there are no studies investigating the relationship of both socioeconomic and environmental factors with PA and ST trajectories in one study population; and especially in Germany, longitudinal studies investigating PA and ST are lacking. It is still not clearly described to which extent PA decreases and ST increases during adolescence and which percentage of adolescents do not follow this negative trajectory. There is also still a lack of knowledge on the associations of individual and environmental factors with different PA and ST trajectories. Therefore, the aim of this study was to add longitudinal data to the literature by examining patterns of change in PA and ST among school students over two years and to investigate associations of these trajectories with individual and environmental factors (e.g., sex, body mass index (BMI), socioeconomic status, migration background, and school type).

2. Materials and Methods

2.1. Study Design and Participants

The current analyses are based on two intervention groups of the study sample of the "Berlin Evaluates School Tobacco" (BEST)-prevention study, a three armed cluster randomized controlled trial (RCT) conducted from 2010 to 2014 in Berlin [32,33]. The RCT's aim was to evaluate a parent-involved smoking prevention for 7th grade students of high schools and integrated secondary schools. Both intervention groups received information about smoking, additionally the parents of one group received information regarding rules to encourage their children not to start or to stop smoking. The intervention did not include any information regarding physical activity or screen time behaviours. The students of the control group, however, received information about nutrition and physical activity and were therefore excluded from the present analyses. Separate signed written informed consent was required from participating students as well as from at least one parent/caregiver. The study was approved by the ethical review committee of the Charité-Universitätsmedizin Berlin, Germany (EA1/133/10).

The present analysis uses cohort type data assessed in the RCT (two intervention groups only). The aim of the present analysis is to investigate health behaviour changes in 7th grade students over two years.

2.2. Data Collection

Data were collected at baseline, after 1 and 2 years during classes using self-report questionnaires that were developed on the basis of the standardised and validated questionnaires for adolescents, such as the ones used in the HBSC survey [34–36]. Details of the data assessment and a description of the variables were described previously [28,33].

2.3. Variable Definitions

2.3.1. Moderate-to-Vigorous Physical Activity

Moderate-to-vigorous physical activity (MVPA) was assessed using three adapted items of the HBSC questionnaire: 'number of days of physical activity', 'weekly hours of physical activity', and 'WHO recommendations fulfilled' (fulfilled if 60 min of physical activity per day were reported).

2.3.2. Screen Time Behaviour

Total recreational screen time comprised watching TV and playing at the computer and/or gaming consoles using items of the HBSC questionnaire. Data for TV and computer use were assessed as 'hours per weekday' and 'hours per weekend day', respectively. The maximal possible amount of ST that could be reported was 14 h per day; however, we defined 11 h per weekday as maximal plausible amount of ST, while for weekend days we made no changes. According to international guidelines, 'screen time recommendations fulfilled' was coded as 'yes', if total recreational screen time (TV and computer) was 2 h per day or less [11,12].

2.3.3. Sex, Age, and Anthropometric Data

We assessed sex, age, height, and weight with self-report questionnaires and calculated the body mass index (BMI). According to Cole, we assigned students into four categories, underweight (<10th percentile), normal (10th–<90th percentile), overweight (90th–<95th percentile), and obese (95th percentile or higher) [37,38].

2.3.4. Migration Background

A student was defined as having a migration background if he or she was not born in Germany or if at least one parent was not born in Germany but moved to Germany after 1949 [39].

2.3.5. School Type

There are two school types in Berlin: high schools (Gymnasien) and integrated secondary schools (Integrierte Sekundarschulen). Both schools can be finished with a secondary school leaving certificate after 10th grade or with a high school diploma after 12th grade (high schools) or 13th grade (integrated secondary schools). The academic requirements are higher in high schools than in integrated secondary schools, and the number of school lessons per week differs slightly (33–34 vs. 31–32 lessons per week at high schools and integrated secondary schools, respectively) [40,41]. All schools in Berlin offer three lessons (two hours) of physical education per week according to a central curriculum [42,43].

2.3.6. Socioeconomic Status

The socioeconomic status (SES) was assessed using the family affluence scale (FAS), a validated instrument to assess the material affluence of a family asking for the number of motor vehicles, computers, number of holidays during the last year, and if the child has his/her own bedroom. A score of 0–3 points indicates low affluence, a score of 4–5 middle affluence, and a score of 6–7 high affluence [44].

2.3.7. Parental Work Status

It was assessed via self-report, if both parents work, only one parent, or none of the parents. No information was obtained regarding working hours or workplaces.

2.3.8. Outcomes

The primary outcomes were the PA and ST trajectories (changes) from baseline to 24-month follow-up. We defined four trajectories for PA and ST, respectively. At least 5 h per week of leisure time PA were defined as active taking the 2 h per week of physical education in school into account. For ST, 14 h per week were defined as high screen time behaviour. A relevant change between baseline and 24-month follow-up was defined for PA as a difference of at least 30 min per week and for ST as a difference of at least 3 h per week, reflecting about a tenth of the baseline duration.

We converted the PA trajectories 'consistently high' and 'increasing' into 'positive PA trajectory' and 'consistently low' and 'decreasing' into 'negative PA trajectory'. For screen time, 'consistently low' and 'decreasing' were converted into 'positive ST trajectory', while 'consistently high' and 'increasing' were converted into 'negative ST trajectory' (Table 1).

Table 1. Definition of physical activity and screen time trajectories.

Trajectory	Baseline	24-Month Follow-Up	Trajectory
Moderate-to-vigorous physical activity (PA) (h per week)			
Consistently high	≥5	≥5	Positive PA trajectory
Increasing	<5	≥5 [1]	
Decreasing	≥5	<5 [1]	Negative PA trajectory
Consistently low	<5	<5	
Screen time (ST) (h per week)			
Consistently low	≤14	≤14	Positive ST trajectory
Decreasing	>14	≤14 [2]	
Increasing	≤14	>14 [2]	Negative ST trajectory
Consistently high	>14	>14	

[1] Difference between 24-month follow-up and baseline at least 30 min per week; [2] Difference between 24-month follow-up and baseline at least 3 h per week.

2.3.9. Statistical Analysis

All statistical analyses were performed for the 12–13 years old students due to the small number of students younger than 12 and older than 13 years. We used all data available for the respective analysis; missing data were not imputed. Characteristics of schools and students were analysed by descriptive statistical methods (e.g., mean and standard deviation (SD), frequencies, and percentages) without taking the clustering of classes or schools into account.

For the analyses of associated factors, the four outcome categories (consistently low, decreasing, increasing, and consistently high) were combined into two categories (positive, negative) for PA and ST, respectively. A generalized linear mixed model (GLMM with random intercept and a logit link function) was used taking the nested structure of the data with both fixed and random effects into account. The random factors 'school' and 'class within school' (as nested factor) were included into the models, while other influencing factors were considered fixed. Results are presented as (adjusted) odds ratios (OR) and 95% confidence intervals (CI). All *p*-values are considered exploratory (no adjustment for multiple testing). Analyses were performed using the software package SAS 9.4 (SAS Institute Inc., Cary, NC, USA) and IBM SPSS Statistics 24 (IBM Corp. Released 2016. IBM SPSS Statistics for Windows, Version 24.0. Armonk, NY, USA: IBM Corp.).

3. Results

3.1. Participant Characteristics

Out of 2122 students who participated in the baseline assessment, 1795 (84.6%) attended the 24-month follow-up. The baseline sample was 50.2% girls, with a mean age of 12.5 ± 0.7 years. Of all students, 43.3% attended high school, 49.1% had high family affluence, and 34.2% had migration background (Table 2).

Table 2. Baseline characteristics of participants.

	Boys	Girls	Total
	N (%) or Mean ± Standard Deviation (SD)		
Students			
Number	1057 (49.8)	1065 (50.2)	2122
Age (years)	12.6 ± 0.7	12.5 ± 0.6	12.5 ± 0.7
Anthropometric data (N = 1895)			
BMI [1] (kg/m^2)	19.0 ± 3.1	18.3 ± 2.8	18.7 ± 3.0
Underweight (BMI < 10th percentile) [2]	104 (11.0)	186 (19.6)	290 (15.3)
Normal weight (BMI 10th–<90th) percentile) [2]	686 (72.5)	677 (71.3)	1363 (71.9)
Overweight (BMI 90th–<97th percentile) [2]	136 (14.4)	79 (8.3)	215 (11.3)
Obesity (BMI ≥ 97th percentile) [2]	20 (2.1)	7 (0.7)	27 (1.4)
Migration background (N = 1984)			
no	657 (66.2)	649 (65.4)	1306 (65.8)
yes	335 (33.8)	343 (34.6)	678 (34.2)
School type			
High school [3] students	417 (39.5)	502 (47.1)	919 (43.3)
Integrated secondary school [4] students	640 (60.5)	563 (52.9)	1203 (56.7)
Socioeconomic status (SES)			
Family affluence scale (FAS) (N = 1781)	5.3 ± 1.4	5.1 ± 1.4	5.2 ± 1.4
high (FAS 6–7)	471 (53.2)	404 (45.1)	875 (49.1)
moderate (FAS 4–5)	311 (35.1)	374 (41.7)	685 (38.5)
low (FAS 0–3)	103 (11.6)	118 (13.2)	221 (12.4)
Parent's working status (N = 1994)			
Both parents work	678 (68.3)	666 (66.5)	1344 (67.4)
One parent works	284 (28.6)	302 (30.1)	586 (29.4)
No parent works	30 (3.1)	34 (3.4)	64 (3.2)

[1] Body mass index (BMI). [2] BMI percentiles according to Cole et al. [37,38]. [3] High school: 5th or 7th to 12th grade, highest graduation: high school diploma. [4] Integrated secondary school: integration of different school types, 7th to 13th grade, highest graduation: high school diploma.

3.2. PA and ST Changes

From baseline to 24-month follow-up the proportion of students who met the PA recommendations decreased from 13.2% to 9.4% (boys: 16.5% to 12.8%, girls: 10.0% to 6.1%). The proportion of students who reported a PA frequency of at least three times per week decreased, while the proportion of students with a lower frequency increased. In contrast, mean weekly hours of PA were stable over the two-year study period (5.5 ± 5.2 and 5.4 ± 5.4 h) (Table 3).

The proportion of students who fulfilled the screen time recommendations decreased from 25.0% to 19.4% (boys: 17.8% to 12.0%, girls: 31.9% to 26.6%). Total screen time increased by 2.4 ± 19.5 (95% CI: 1.5; 3.4) hours per week (boys: 3.7 ± 19.8 (2.4; 5.1), girls: 1.2 ± 19.2 (0.1; 2.5)). In boys, the increase in screen time was exclusively caused by computer use and gaming, while TV use remained stable. In girls, only TV hours per week showed an increase.

3.3. PA and ST Trajectories

Regarding PA, 'consistently low' was the largest trajectory, followed by 'consistently high', 'decreasing', and 'increasing'. Students in the positive trajectories engaged in about three times as much PA as students in the negative trajectories (Figure 1).

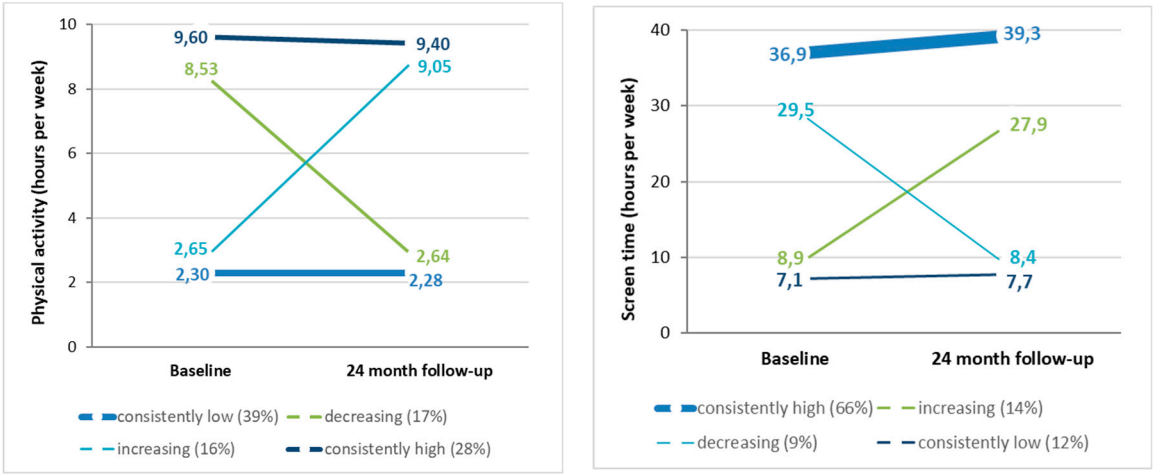


Figure 1. Trajectories (mean hours per week) among 7th grade to 9th grade students for (**a**) physical activity and (**b**) screen time (lines' weights reflect size of trajectories).

Regarding ST, 'consistently high' was by far the largest trajectory, followed by 'increasing', 'consistently low', and 'decreasing'. While students in the positive trajectories spent less than 10 h per week in ST behaviour, in the increasing and the consistently high trajectory students spent three to four times the time with ST, respectively. Trajectories were similar for boys and girls (data not shown). Weekly hours spent in PA and ST behaviour are presented in Figure 1.

Table 3. Changes over two years in physical activity (PA) and screen time (ST) behaviour among 7th grade to 9th grade students.

	Boys			Girls			Total		
	N [1]	**Baseline**	**24-month Follow-Up**	**N** [1]	**Baseline**	**24-month Follow-Up**	**N** [1]	**Baseline**	**24-month Follow-Up**
Physical activity		(mean ± SD or %)			(mean ± SD or %)			(mean ± SD or %)	
PA at least 60 min/day [2]	854	16.5	12.8	837	10.0	6.1	1735	13.2	9.4
PA frequency	859			869			1728		
About every day		25.0	21.9		17.8	10.1		21.4	16.0
About 3–5/week		45.8	42.8		36.6	31.5		41.1	37.2
About 1–2/week		23.9	27.0		36.5	42.3		30.2	34.7
About 1–2/month		3.6	5.6		6.4	11.2		5.0	8.4
Never		1.7	2.7		2.6	4.8		2.2	3.8
PA duration	742			768			1510		
Hours per week		6.3 ± 5.9	6.4 ± 5.6		4.6 ± 4.3	4.5 ± 5.0		5.4 ± 5.2	5.4 ± 5.4
Difference between baseline and 24-month follow-up		0.03 ± 7.4			–0.06 ± 5.2			0.015 ± 6.4	
Screen time		(mean ± SD or %)			(mean ± SD or %)			(mean ± SD or %)	
ST ≤ 2 h/day [3]	853	17.8	12.0	877	31.9	26.6	1730	25.0	19.4
TV (hours/week)	873	17.7 ± 12.3	17.5 ± 12.1	887	15.8 ± 11.7	16.6 ± 11.3	1760	16.8 ± 12.0	17.0 ± 11.7
Computer (hours/week)	862	14.8 ± 12.3	18.8 ± 12.9	887	10.5 ± 11.9	10.9 ± 13.6	1749	12.6 ± 12.3	14.8 ± 13.9
Total screen time	853			877			1730		
Hours/week		31.9 ± 19.5	35.6 ± 18.7		25.9 ± 19.0	27.1 ± 19.1		28.9 ± 19.5	31.3 ± 19.4
Difference between baseline and 24-month follow-up		3.7 ± 19.8			1.2 ± 19.2			2.4 ± 19.5	

[1] Data of both assessment points available, [2] WHO recommendations [10], [3] Movement recommendations [9,11].

3.4. Factors Associated with PA and ST Trajectories

Regarding PA, the percentage of students in the positive and the negative trajectory was 44% and 56%, respectively. There were more boys than girls (63% vs. 37%) in the positive PA trajectory. School type and socioeconomic factors were similar between the two groups. A slightly higher proportion of students in the positive PA trajectory had higher affluence than middle affluence compared to students in the negative PA trajectory; proportions of low affluence were similar (descriptive results, Table 4).

Table 4. Physical activity and screen time trajectories among 7th grade to 9th grade students.

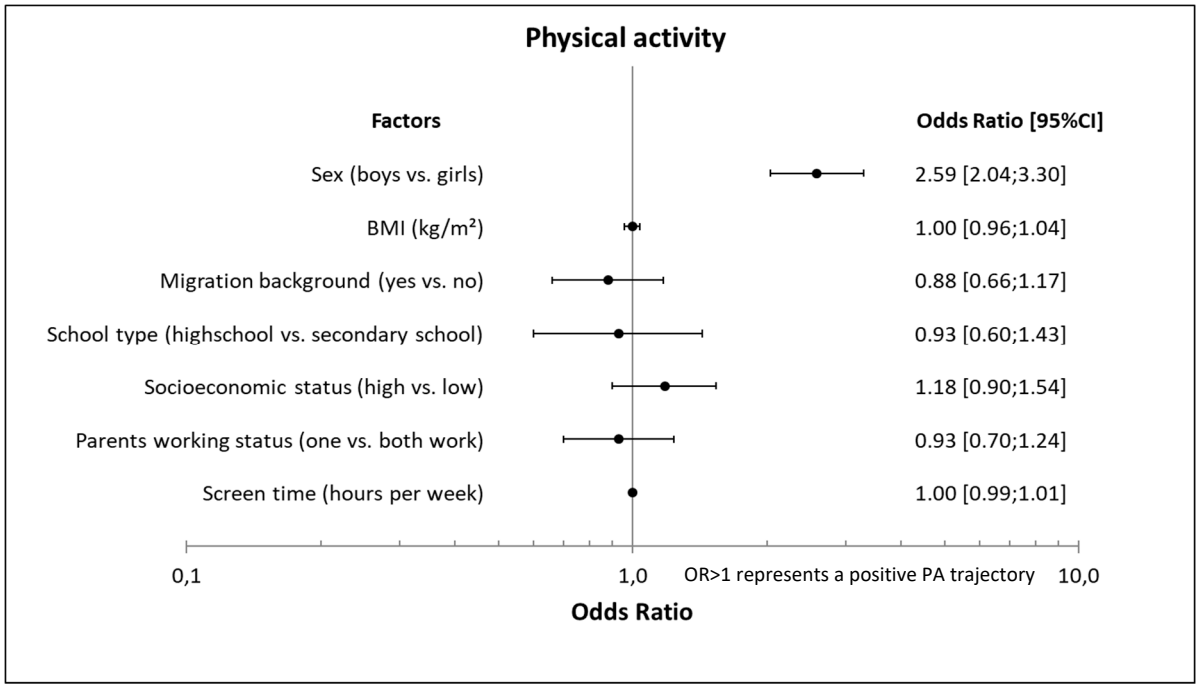
	PA Trajectories [1] (N = 1510)		ST Trajectories [1] (N = 1730)	
	Positive	**Negative**	**Positive**	**Negative**
Baseline Variables		%		
Students	44.1	55.9	20.5	79.5
Sex				
Boys	62.9	38.3	29.9	54.3
Girls	37.1	61.7	70.1	45.7
BMI [2] categories	(N = 1373)		(N = 1557)	
Underweight (BMI < 10th percentile)[3]	13.5	16.5	21.1	13.5
Normal weight (BMI 10th–<90th percentile) [3]	75.0	71.6	69.9	73.4
Overweight (BMI 90th–<97th percentile) [3]	10.4	10.3	8.3	11.5
Obesity (BMI ≥ 97th percentile) [3]	1.1	1.6	0.6	1.6
Migrant background	(N = 1434)		(N = 1640)	
yes	28.6	33.8	27.6	34.0
School type				
High school students [4]	46.8	49.9	59.6	42.7
Integrated secondary school students [5]	53.2	50.1	40.4	57.3
Socioeconomic status (SES)				
Individual SES (family affluence scale; FAS)	(N = 1501)		(N = 1721)	
high (FAS 6–7)	55.4	47.5	61.3	46.2
moderate (FAS 4–5)	33.3	40.3	31.1	40.0
low (FAS 0–3)	11.3	12.2	7.7	13.8
Parents' working status	(N = 1441)		(N = 1649)	
Both parents work	72.4	69.1	71.5	68.2
One parent works	24.9	27.7	25.3	28.6
No parent works	2.7	3.2	3.2	3.2

[1] Definition of trajectories is presented in Table 1. [2] Body mass index. [3] BMI percentiles according to Cole et al. [37,38]. [4] High school: 5th or 7th to 12th grade, highest graduation: high school diploma. [5] Integrated secondary school: integration of different school types, 7th to 13th grade, highest graduation: high school diploma.

Regarding ST, only 21% of students followed a positive ST trajectory. There were more girls and high school students in the positive ST trajectory, and family affluence was higher than in the negative ST trajectory (descriptive results, Table 4). All characteristics of the positive and negative PA and ST trajectories are presented in Table 4.

Multivariable regression analyses showed that boys had 2.6 (95% CI: 2.04; 3.30) higher odds to follow a positive PA trajectory than girls; no association was found for SES, school type, migration background, parental work status, BMI, or screen time at baseline (Figure 2).

Girls had a 2.4 (1.82; 3.27) higher odds to follow a positive ST trajectory than boys. Attending a high school (OR 1.59 (1.10; 2.33)) and a high SES (OR 1.99 (1.14; 3.47)) were also associated with following a positive ST trajectory. BMI, migration background, working status of parents, and physical activity at baseline were not associated (Figure 2).



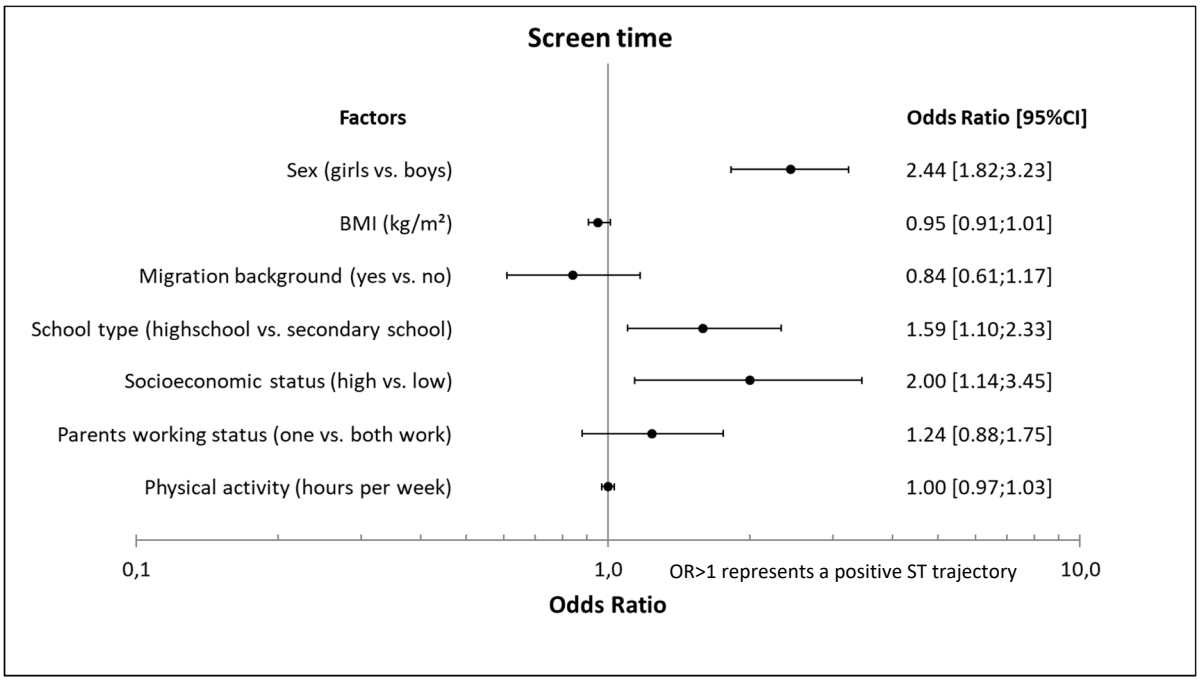


Figure 2. Associations of potential determinants with a positive (**a**) PA (N = 1247) and (**b**) ST (N = 1316) trajectory among 7th to 9th grade students.

4. Discussion

4.1. Main Study Findings and Implications

In the overall sample, time spent in moderate-to-vigorous physical activity did not change substantially, while screen time increased over the two-year study period. Regarding the four defined

trajectories of PA and ST, respectively, we observed large differences regarding these behaviours. Mean weekly PA was over three times higher among students in the positive PA trajectory than in the negative. In contrast, mean weekly ST was up to four times lower in the positive ST trajectory compared to the negative. These results show that focusing on average values can obscure substantial differences within the target population. Our study shows that boys are more likely to follow a positive physical activity trajectory than girls. A positive screen time trajectory, however, is more often associated with being a girl, having a high socioeconomic status, and attending a high school.

Regarding the longitudinal changes of PA and SB, similar results were reported by Harding et al., who described a substantial increase of SB and only a minimal decrease of MVPA among 12-year-old school students over four years (2008/2009−2012/2013) [45]. One explanation for this observation is that rather light PA (LPA) is replaced by sedentary time, which is often not reported, when the study focused on MVPA, as did our study [46]. Another explanation could be a too short duration of the follow-up. Studies describing a decline of both LPA and MVPA in youth more often have a longer follow-up than the present study and the above-mentioned studies: Dalene et al. reported longitudinal changes of MVPA and sedentary time among a Norwegian youth cohort (age 9−15 years) over six years from 2005/2006 to 2011/2012; however due to only two measurements, no specific age was identified where PA decreased. Ortega et al. stated a linear decline of MVPA among a Swedish and Estonian youth and adolescent cohort (age 8−18 and 15−25 years) which was followed up for 10 years from 1998 to 2008 [8,47]. Despite the vast amount of data, it is still difficult to draw conclusions from the existing studies since results regarding specific age-related PA and ST changes, as well as predictors, vary greatly among different studies [21,48,49].

What our study adds to these longitudinal data is the description of different trajectories for PA and ST. To our knowledge, this is the first German study investigating PA and ST trajectories and their predictors in school students. In addition to the longitudinal design, a novelty of our study is the size of the study sample and the location in a metropolitan area including a high percentage of students with migration background and different levels of socioeconomic status which have been shown to be representative of Berlin school students [28,50].

Regarding PA, only males were associated with a positive PA trajectory. This result is in line with other studies [49,51,52]. For the total sample, no other factors predicted a positive PA trajectory; stratified for sex, however, we found that girls attending a high school were less likely to follow a positive PA trajectory compared to girls attending an integrated secondary school. Similar results were reported in a cross-sectional study (2009/2010) by Czerwinski et al. [25]. This finding may partly be explained by the higher workload of students attending a high school in addition to a higher performance orientation among girls [53].

Following a positive ST trajectory was predicted by several factors. Females were associated with a positive ST trajectory which could be explained by the higher use of electronic gaming among boys, while girls tend to spend their time more often socializing with friends [54,55]. While some studies report a greater increase of SB among girls than boys, that was not the case in our study, probably because we assessed only screen time and not sedentary behaviour [19,56]. High socioeconomic status compared to low SES also predicted a positive ST trajectory. One explanation might be the fact that parents with higher SES have stricter rules regarding gaming and the use of electronic devices [57]. The third factor associated with a positive ST trajectory was attending a high school, probably due to higher parental education among students attending a high school and the somewhat higher proportion of girls among high school students. The number of school lessons differed only slightly between the two school types and does not seem to be a cause for differences in recreational ST time; however, the higher academic requirements among high schools could cause lower screen time in high school students [40,41].

Interestingly, baseline PA was not associated with ST trajectories and baseline ST was not associated with PA trajectories. This is in contrast to a study by Lizandra et al. who illustrated that MVPA was displaced by screen time between 2010 and 2013 [58]. It is possible, however, that ST displaced LPA

rather than MVPA which we did not measure individually. In contrast to other studies investigating trajectories, BMI was not associated with PA or ST [30,31].

Health behaviours are complex and even if our study cannot explain causal relationships between the associated variables and the PA and ST trajectories, several implications are drawn from our study results. One implication is to consider that there is no intervention suitable for all boys, all girls, or even all students together. Our study results help to distinguish vulnerable subgroups from the student population and can be transferred to similar contexts as ours, namely metropolitan areas with different types of schools, a broad range of SES, and a high proportion of students with migration background.

To describe the implications more precisely, integrated secondary schools could consider addressing the high screen time behaviour among boys through information campaigns for students including parents as described in a recent systematic review [59], class competitions similar to already existing programs for smoking prevention [60], or extracurricular activities as replacement for gaming at home. Although our study population consisted of high school students, a systematic review showed that school-based PA campaigns should address even younger age groups, include parents, and be monitored carefully [59]. Prevention campaigns for screen time reduction are still scarce. A study by Vik et al. reported no differences in screen time behaviour between the intervention and control group, however, the intervention group showed more positive attitudes towards breaking up sitting time [61]. In addition, since integrated secondary schools are frequented more often by students with a low SES, programs have to consider the lower education and/or fewer resources of the parents, when establishing prevention programs. Kobel et al., for instance, described a positive intervention effect for students having parents with a low educational level [62]. High schools, on the other hand, could focus on physical activity promotion, especially among girls, an approach that Demetriou et al. are planning to use in a study focusing on girls' PA [63]. A further approach for both types of schools would be to increase the hours of physical education. Our study results add new evidence to the ongoing debate in Germany [64].

4.2. Strengths and Limitations

The strengths of the present study include the large sample size, the longitudinal approach of the study, as well as the distribution of migration background, SES, and gender, which appear to be very similar to the student population of Berlin [50]. Another strength is that we took school type into account not only as an associated factor but as a predictor of PA and ST trajectories. Third, we reported PA and ST at the same time and described reciprocal associations; many other studies only focus on one of these two important health behaviours.

Some limitations are considered as well. First, since the aim of the original study was to evaluate smoking behaviour and did not focus primarily on physical activity, PA was not assessed objectively. Self-report of children and adolescents, especially regarding PA, may lead to biased results through misreporting. However, the HBSC questionnaire was validated and used in broad samples of students [35]. Future studies should use accelerometry or other measures to objectively assess PA and ST. Another limitation of the present study is that we assessed screen time only based on the use of TV, computer, and video games as assessed by the HBSC questionnaire [65]. Other increasingly popular screen devices (e.g., smartphones, tablets) were not taken into account, which may have led to an underestimation of ST.

5. Conclusions

Among a cohort of 7th grade students that was followed over a two-year period, males were associated with a positive physical activity trajectory (PA remained high or increased), while females, high socioeconomic status, and attending a high school were associated with a positive screen time trajectory (ST remained low or decreased). Taking these results into account could help to tailor prevention programs in order to address special target groups with diverse PA and ST patterns.

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2.1.3. Körperliche Aktivität im zeitlichen Verlauf bei Personen mit türkischem Hintergrund in Deutschland

***Krist, L.**, Dornquast, C., Reinhold, T., Becher, H., Icke, K., Danquah, I., Willich, S.N., Keil, T.:* Physical Activity Trajectories among Persons of Turkish Descent Living in Germany-A Cohort Study. *Int J Environ Res Public Health. 2020;17(17).*

Körperliche Aktivität kann auf unterschiedliche Arten erhoben werden. In Längsschnittstudien wird oft das sogenannte „trajectory", also der zeitliche Verlauf, verwendet, um die Entwicklung von körperlicher Aktivität zu beschreiben, aber auch um eine Population gemäß ihren individuellen Verläufen in Cluster einzuteilen. Da wenig über solche Aktivitätsverläufe bei Personen mit Migrationshintergrund bekannt ist, war das Ziel dieser Studie, in einer Population von türkeistämmigen Berlinern die Aktivitätsverläufe über einen Zeitraum von 6 Jahren zu beschreiben und Determinanten für positive und negative Verläufe zu explorieren.

Die körperliche Aktivität wurde zu Baseline (2011/2012) und nach einem Abstand von 6-7 Jahren (2018/2019) erfasst. Die Aktivitätsverläufe wurden definiert und in vier Kategorien eingeteilt: „inaktiv", „abnehmend", „zunehmend" und „stabil aktiv". Mittels multivariabler Regression wurden Determinanten für einen stabil aktiven Verlauf berechnet.

In die Studie wurden 197 Personen (61% Frauen, Alter 50±13 Jahre) eingeschlossen, von denen über den 6-7-jährigen Beobachtungszeitraum 19,3% stabil aktiv und 23,7% inaktiv waren, während 12,2% abnehmende und 42,1% zunehmende Aktivität zeigten. Die Regressionsanalyse zeigte, dass eine gleichbleibend hohe Aktivität („stabil aktiv") mit einem hohen Bildungsstand, deutscher Staatsbürgerschaft, deutsch als gewählter Fragebogensprache und normalem BMI unabhängig voneinander assoziiert war.

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Physical Activity Trajectories among Persons of Turkish Descent Living in Germany—A Cohort Study

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Abstract: Physical activity (PA) behavior is increasingly described as trajectories taking changes over a longer period into account. Little is known, however, about predictors of those trajectories among migrant populations. Therefore, the aim of the present cohort study was to describe changes of PA over six years and to explore migration-related and other predictors for different PA trajectories in adults of Turkish descent living in Berlin. At baseline (2011/2012) and after six years, sociodemographics, health behavior, and medical information were assessed. Four PA trajectories were defined using data of weekly PA from baseline and follow-up: "inactive", "decreasing", "increasing", and "stable active". Multivariable regression analyses were performed in order to determine predictors for the "stable active" trajectory, and results were presented as adjusted odds ratios (aOR) with 95% confidence intervals (95%CI). In this analysis, 197 people (60.9% women, mean age ± standard deviation 49.9 ± 12.8 years) were included. A total of 77.7% were first-generation migrants, and 50.5% had Turkish citizenship. The four PA trajectories differed regarding citizenship, preferred questionnaire language, and marital status. "Stable active" trajectory membership was predicted by educational level (high vs. low: aOR 4.20, 95%CI [1.10; 16.00]), citizenship (German or dual vs. Turkish only: 3.60 [1.20; 10.86]), preferred questionnaire language (German vs. Turkish: 3.35 [1.05; 10.66]), and BMI (overweight vs. normal weight: 0.28 [0.08; 0.99]). In our study, migration-related factors only partially predicted trajectory membership, however, persons with citizenship of their country of origin and/or with poor language skills should be particularly considered when planning PA prevention programs.

Keywords: physical activity; physical activity trajectories; migrants; cohort study

1. Introduction

Physical activity (PA) contributes to a broad range of health benefits and is one of the most important protective factors for a variety of chronic diseases [1–6]. In later life, PA can prevent cognitive decline and improve physical functioning [7–10]. Among the elderly, activities of daily living can longer be maintained when engaging in regular PA [11,12]. Finally, the beneficial effects might delay premature mortality and increase one's lifespan [6,13,14].

A common methodological approach to describe PA is its assessment at a single point in time [15]. However, this approach does not take into account the dynamic nature of PA. Thus, for a more detailed description of PA over a longer time period and a better understanding of its complexity, prospective trajectories including two or more time points are proposed [16,17]. PA trajectories can then be used to predict future health and physical functioning and are therefore a good measure for PA [5,9,11,15,18–21]. In addition, the identification of associated factors for specific PA trajectories is important for tailoring prevention efforts.

Although the favorable effects of PA are widely proven and recognized, adherence to common recommendations is low in high-income countries including Germany, and PA tends to decline over one's lifetime [22–24]. Many studies have been conducted to investigate reasons for this [25]. In a recent systematic review investigating PA trajectories, male sex, being Caucasian, non-smoking, having low television viewing time, higher socioeconomic status, no chronic illnesses, and family support for PA were positively associated with stable or increasing PA trajectories [17]. Another study showed associations of education, age, and employment status with PA trajectories [26].

In recent decades, predictors of PA have been described increasingly also in samples of ethnic minorities [27]. This is of great public health importance, since this population group is at special risk due to a high prevalence of overweight and obesity as well as chronic diseases such as diabetes [28]. A recent review and a resulting developed system-based framework reported that PA and sedentary behavior in ethnic minority groups in Europe were mostly associated with social and environmental factors such as sex, religion, and personal or cultural beliefs regarding PA [29,30]. Other studies that investigated associated factors with PA reported acculturation status, length of stay, own migration experience (first migration generation), and citizenship as migration-related factors as well as age, sex, socioeconomic status, employment status, education, psychosocial, and environmental factors [27,31–33]. A study from Australia described language skills and country of origin as predictive factors of PA assuming that the comprehension of prevention measures was easier for migrants from an English-speaking country [34]. A study among Turkish migrants in England and Germany concluded that age, sex, marital status, and the host country, but not acculturation were associated with PA [35].

While there is growing evidence for predictors of PA among migrants in general, longitudinal data on PA and predictors for PA trajectories in this population group are still scarce [33]. Since persons of Turkish descent form the largest group of persons with migration background in Berlin (6% of the Berlin population and 20% of all Berliners with migration background) [36], the aim of our study was to describe different trajectories of PA behavior as well as predictors of these trajectories in a prospective cohort study among persons of Turkish descent living in Berlin, Germany.

2. Materials and Methods

2.1. Study Design and Recruitment

For this cohort study, 557 adults of Turkish descent living in Berlin were recruited via a complex recruitment process (register-based and network approach) using an onomastic procedure to identify persons of Turkish descent. The recruitment strategies have been described by Reiss et al. in more detail [37]. Briefly, the baseline assessment (conducted between 2011 and 2012) was part of the pretest phase of the German National Cohort Study (NAKO) with the aim to evaluate different recruitment strategies among persons of Turkish descent [37,38]. All recruited participants completed a questionnaire and underwent some medical examinations (measurement of body height and weight, blood pressure, blood sample). After 6 years, all participants who had agreed to be re-contacted, received the follow-up questionnaire consisting of questions regarding health status, health behavior, health care utilization, and others. Baseline and follow-up recruitment were conducted using bilingual written invitations, as well as telephone contacts and home visits performed by bilingual study staff. A more detailed description of the follow-up recruitment has been provided by Krist et al. [39]. The study was approved by the ethical review committee of the Charité - Universitätsmedizin Berlin, Germany,

and registered at the German Clinical Trials Register under the registration number DRKS00013545. Written informed consent was obtained from all participants.

2.2. Measures

2.2.1. Physical Activity

Moderate-to-vigorous physical activity was assessed with two questions. 1. "On how many days per week are you physically active (any activity that increases your heart rate and makes you get out of breath) during an average week?"; participants could enter a number. 2. "How long are you physically active on average on those days when you sweat or are out of breath due to your physical activity?". Response options for that question were "less than 10 min", "10 to under 30 min", "30 to under 60 min", and "60 min or more". PA minutes per week were calculated according to Krug et al. using the mean value of the answer categories for the question on duration and estimating the top category conservatively at 60 min [40]. Duration of weekly PA was then categorized into "inactive" (no activity), light PA (<150 min/week), moderate PA (150– <300 min/week), and high PA (≥300 min/week) in order to define the PA trajectories. Four PA trajectories were defined: "inactive", if no activity was reported at baseline and follow-up; "decreasing", if PA activity level was lower at follow-up than at baseline; "increasing", if PA activity level was higher at follow-up than at baseline; and "stable active", if PA activity level remained the same (at least light PA). More details are shown in Supplementary Table S1.

2.2.2. Socio-Demographics

As socio-demographic variables, we included sex (male/female), age (in years), marital status (married/not married) and educational level defined as years of attained formal education in Turkey and/or Germany (<10 years, 10–12 years, and >12 years), and net household income (EUR ≤ 1500 per month/EUR > 1500 per month). Age and household income were assessed at baseline and follow-up, all other variables were assessed only at baseline.

2.2.3. Migration-Related Factors

Three migration-related variables were included. Firstly, migration generation was compiled using information about the country of birth and the question whether participants had lived in Germany since birth. Participants who were born in Turkey or another country were categorized into the group with their own migration experience (1st generation), while participants who were born in Germany were defined as the group without migration experience (2nd generation). The second variable was citizenship, which was dichotomized into Turkish, if it was only Turkish, and into German, if it was German and Turkish or German alone. As a third variable, the chosen language of the questionnaire (German or Turkish) was included, since the participants' choice reflects their language skills better than information about their mother tongue.

2.2.4. Health Behavior and Diseases

At baseline, trained study personnel measured body height to the nearest 0.1 cm and body weight to the nearest 0.1 kg using a calibrated integrated measurement station (SECA model 764, Seca®, Hamburg, Germany). Body mass index (BMI) was calculated from these measurements as weight over height squared in kg/m^2, and categorized into normal weight (BMI 18.5 to <25.0kg/m^2), overweight (BMI 25.0 to <30.0kg/m^2), and obesity (BMI ≥30.0kg/m^2). BMI at follow-up was calculated using measured height at baseline and self-reported weight at follow-up. Smoking status was assessed at baseline and follow-up, and categorized into smoker (regular smoking), ex-smoker, and never-smoker. Lastly, lifetime prevalence of hypertension, diabetes, and dyslipidemia (self-report of physician's diagnosis), assessed at baseline and follow-up, was considered.

2.3. Statistical Analyses

We considered our statistical approach as explorative rather than strictly hypotheses testing. For the definition of PA trajectories, we used the variables "weekly PA baseline" and "weekly PA follow-up" and defined four groups: "inactive", "decreasing", "increasing", and "stable active". A detailed description of the four trajectories is presented in the Methods section and in Supplementary Table S1. The trajectories were analyzed using descriptive methods of means and standard deviations for continuous data and absolute and relative frequencies for categorical data. Differences in characteristics by trajectory were tested with chi-square test for categorical variables and ANOVA for continuous variables. A multivariable logistic regression analysis was conducted to investigate associations between baseline variables (exposure) and "stable active" trajectory membership (outcome). Results of the multivariable regression analysis were presented as odds ratios (OR) with 95% confidence intervals (CI). The analyses were performed using SPSS Statistics for Windows (25.0.0.1, IBM Corp., Armonk, NY, USA). Creation of Sankey diagrams was performed using displayr.com (Displayr, Sydney, Australia).

3. Results

3.1. Characteristics of the Study Sample and PA Trajectories

Of the 557 baseline participants, 249 completed the follow-up questionnaire (further referred to as "participants"); the group of "non-participants" consists of 248 persons who refused to the follow-up actively or passively and 60 persons who could not be re-contacted. Among the non-participants, 247 had complete PA baseline data. Among the participants, 217 had complete baseline data, 220 had complete follow-up data; 197 had complete PA data for both baseline and follow-up and were included in the present analyses. Mean age of the sample was 49.9 ± 12.8 years at follow-up, 60.9% were women, 77.7% were first-generation migrants, and 50.5% had Turkish citizenship.

According to the definition of PA trajectories, 23.7% showed an inactive trajectory, 12.2% a decreasing, 42.1% an increasing, and 19.3% a stable active trajectory. When comparing the four trajectories, we found differences for citizenship, language of questionnaire, and marital status (all p-values < 0.05). Participants in the inactive trajectory were older, more often men, more often had their own migration experience, preferred Turkish as the questionnaire language, and were more often married than the total sample. The decreasing PA trajectory contained mostly women, participants with low educational level and low household income, who preferred more often German as the language, more often had German citizenship, were more often not married, and had high hypertension prevalence and incidence. Participants in the increasing PA trajectory had mostly Turkish citizenship, high BMI, and were smokers. The stable active trajectory contained mostly participants with a high educational level and high net income, with German or dual citizenship and German as the preferred questionnaire language, as well as the most participants with normal weight. More details of the trajectory characteristics are shown in Table 1.

3.2. PA Trajectories among Participants and Non-Participants

Among both participants and non-participants, over half of the subjects were inactive at baseline (52% among participants, 63% among non-participants), and about 30% reported light PA, while only 12% and 8% reported moderate or high PA, respectively. Overall, PA increased among the participants over the period of six years, whereas 32% were reporting no activity at all at follow-up. PA trajectories of participants and non-participants are shown in Figure 1a,b, respectively.

Figure 2 shows the four PA trajectories of the participants.

Table 1. Characteristics of total sample and physical activity (PA) trajectories.

Characteristics	Total *n* = 197		Physical Activity Trajectories								
			Inactive *n* = 52 (23.7%)		Decreasing *n* = 24 (12.2%)		Increasing *n* = 83 (42.1%)		Stable Active *n* = 38 (19.3%)		*p*-Value [1] (Baseline; Follow-up)
	baseline	follow-up	baseline	follow-up	baseline	follow-up	baseline	follow-up	baseline	follow-up	
	% or mean ± SD										
Time-stable (assessed only at baseline)											
Sex											0.275
Male	39.1		48.1		25.0		37.3		39.5		
Female	60.9		51.9		75.0		62.7		60.5		
Education											0.185
<10 years	36.5		36.5		41.7		37.3		31.6		
10–12 years	37.6		42.3		29.2		41.0		28.9		
>12 years	20.3		13.5		16.7		18.1		36.8		
Missing	5.6		7.7		12.5		3.6		2.6		
Migration generation											0.280
1st generation	77.7		81.6		62.5		78.5		80.6		
2nd generation	22.3		18.4		37.5		21.5		19.4		
Citizenship											0.034
Turkish	50.5		50.0		41.7		61.3		33.3		
German or dual	49.5		50.0		58.3		38.7		66.7		
Preferred language of questionnaire											0.007
Turkish	48.7		59.6		33.3		55.4		28.9		
German	49.5		40.4		66.7		44.6		71.1		
Married											0.032
yes	73.4		86.3		58.3		74.1		63.9		
no	26.6		13.7		41.7		25.9		36.1		
Time varying (assessed at baseline and follow-up)											
Age in years	43.7 ± 12.8	49.9 ± 12.8	45.0 ± 12.9	51.2 ± 12.9	44.1 ± 12.6	50.2 ± 12.5	43.3 ± 12.5	49.6 ± 12.4	42.5 ± 13.9	48.6 ± 14.0	b: 0.810; f: 0.815

Table 1. *Cont.*

Characteristics	Total *n* = 197		Inactive *n* = 52 (23.7%)		Decreasing *n* = 24 (12.2%)		Increasing *n* = 83 (42.1%)		Stable Active *n* = 38 (19.3%)		*p*-Value [1] (Baseline; Follow-up)
											Physical Activity Trajectories
Household net income											b: 0.513; f: 0.479
EUR ≤ 1500	29.4	32.6	34.6	29.4	37.5	45.8	26.5	31.7	23.7	30.6	
EUR > 1500	51.3	57.0	44.2	54.9	54.2	41.7	50.6	59.8	60.5	63.9	
missing	19.3	10.4	21.2	15.7	8.3	12.5	22.9	8.5	15.8	5.6	
BMI [2]											b: 0.334; f: 0.445
Normal weight (18.5 to <25.0 kg/m^2)	26.0	21.8	21.2	16.3	20.8	16.7	24.4	20.8	39.5	34.2	
Overweight (25.0 to <30.0 kg/m^2)	34.7	38.8	44.2	46.9	37.5	41.7	31.7	36.4	26.3	31.6	
Obesity (≥ 30.0 kg/m^2)	39.3	39.4	34.6	36.7	41.7	41.7	43.9	42.9	34.2	34.2	
Smoking behavior											b: 0.877; f: 0.882
Smoker	34.2	32.1	28.8	36.5	37.5	45.8	37.8	42.7	31.6	47.4	
Ex-smoker	28.6	23.5	34.6	19.2	20.8	25.0	26.8	23.2	28.9	28.9	
Never-smoker	37.2	44.4	36.5	44.2	41.7	29.2	35.4	34.1	39.5	23.7	
Physical activity (PA)											
PA minutes per week	51 ± 94	98 ± 118	0	0	171 ± 133	33 ± 48	25 ± 57	179 ± 121	99 ± 105	98 ± 94	b:<0.001; f:<0.001
Active days per week	1.3 ± 2.0	2.2 ± 2.3	0	0	3.7 ± 2.1	1.1 ± 1.7	0.7 ± 1.4	3.8 ± 2.0	2.9 ± 2.0	2.5 ± 1.8	b:<0.001; f:<0.001
Chronic diseases [3]											
Hypertension	25.6	+20.3	22.7	+26.9	30.4	+37.5	28.0	+15.7	20.6	+10.5	b: 0.765; f: 0.027
Diabetes	13.5	+9.6	18.6	+7.7	13.6	+12.5	9.3	+12.0	16.1	+5.3	b: 0.519; f: 0.606
Dyslipidemia	24.7	+17.8	35.6	+25.0	9.1	16.7	22.7	+14.5	25.0	+15.8	b: 0.117; f: 0.456

[1] Chi-square test for categorical variables, ANOVA for continuous variables. [2] Body mass index. [3] Self-report of physician's diagnosis. Baseline: prevalence at baseline. Follow-up: incidence since baseline assessment.

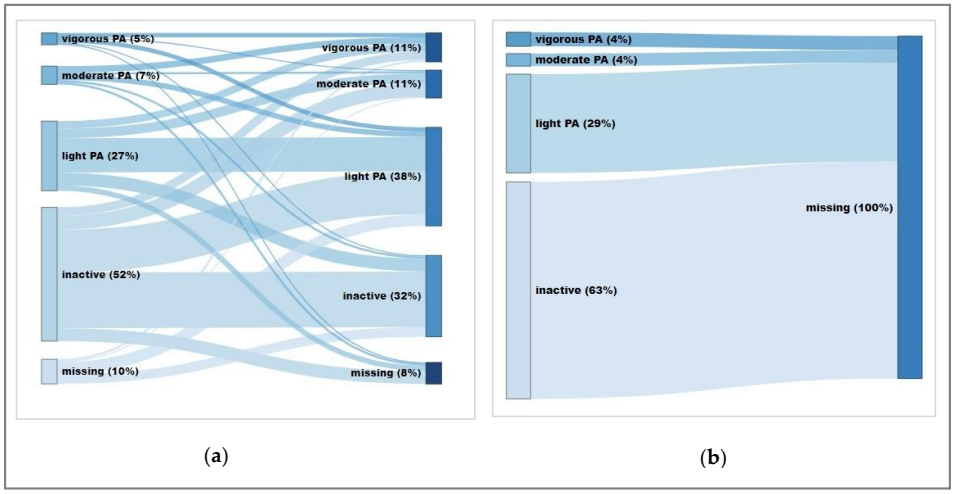

Figure 1. PA trajectories of (**a**) participants (study sample with PA data for at least one assessment point (n = 240)) and (**b**) non-participants with baseline PA data (n = 247). Inactive: no activity; light PA: <150 min/week; moderate PA: 150- <300 min/week; high PA: ≥300 min/week. Software: displayr.com (Displayr, Sydney, Australia).

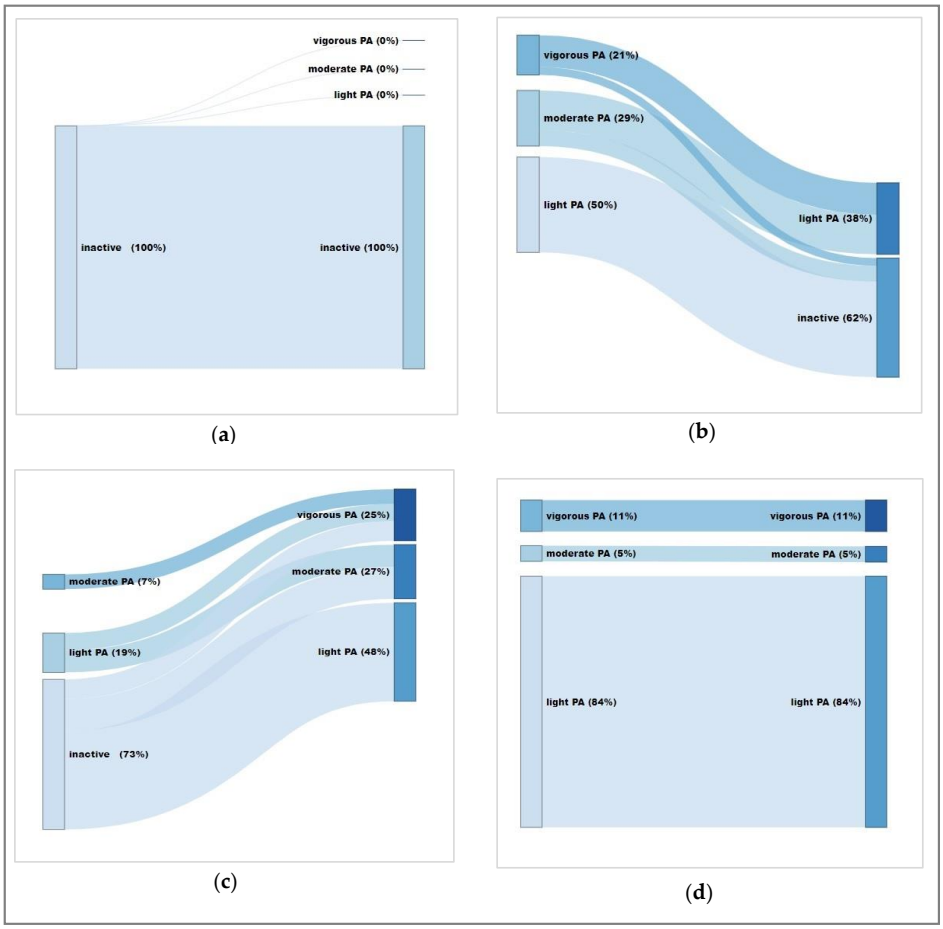

Figure 2. Weekly activity levels from baseline to follow-up for the (**a**) inactive (23.7%), (**b**) decreasing (12.2%), (**c**) increasing (42.1%), and (**d**) stable active (19.3%) trajectories. Inactive: no activity; light PA: <150 min/week; moderate PA: 150- <300 min/week; high PA: ≥300 min/week. Software: displayr.com (Displayr, Sydney, Australia).

3.3. Predictors of PA Trajectories

The results of the univariable and multivariable logistic regression analyses for potential determinants of stable active trajectory membership are presented in Table 2. Predictors for being in the stable active trajectory were a high educational level (OR 4.20, CI [1.10; 16.00]; $p = 0.036$ for more than 12 years of education compared to less than 10 years). Among the migration-related factors, German or dual citizenship (OR 3.60 [1.20; 10.86]; $p = 0.023$) and German as the preferred questionnaire language (OR 3.35 [1.05; 10.66], $p = 0.041$) were positively associated with being in the stable active trajectory. As the only health-related factor, a high BMI was negatively associated with trajectory membership. Compared to normal weight, participants with overweight had 72% lower odds and participants with obesity 71% lower odds (OR 0.28 [0.08; 0.99]; $p = 0.047$ and 0.29 [0.08; 1.08], $p = 0.066$), respectively) for being in the active stable trajectory.

Table 2. Univariable and multivariable logistic regression analysis (complete case analysis, ($n = 157$); **outcome**: stable active trajectory).

Baseline Variables	*n*	Univariable	*p*	Multivariable	*p*
Age (per year)	197	0.99 [0.96; 1.02]	0.516	1.03 [0.97; 1.10]	0.333
Sex	197				
Male vs. female		1.02 [0.49; 2.11]	0.957	0.87 [0.32; 2.39]	0.793
Education	197				
<10 years		Ref.		Ref.	
10–12 years		0.87 [0.36; 2.13]	0.765	0.76 [0.22; 2.63]	0.670
>12 years		2.69 [1.10; 6.61]	0.031	4.20 [1.10; 16.00]	0.036
missing		0.50 [0.06; 4.28]	0.527	n too small	
Household net income	197				
EUR ≤ 1500		Ref.		Ref.	
EUR > 1500		1.61 [0.69; 3.75]	0.275	1.35 [0.38; 4.76]	0.639
missing		1.02 [0.33; 3.14]	0.971	1.42 [0.26; 7.86]	0.689
Migration generation	188				
2nd vs. 1st generation		0.81 [0.33; 2.00]	0.643	0.24 [0.06; 1.05]	0.059
Citizenship	190				
German or dual vs. Turkish		2.4 [1.12; 5.14]	0.024	3.60 [1.20; 10.86]	0.023
Language of questionnaire	197				
German vs. Turkish		2.82 [1.31; 6.07]	0.008	3.35 [1.05; 10.66]	0.041
Marital status	192				
Married (no vs. yes)		1.76 [0.81; 3.80]	0.153	1.50 [0.48; 4.76]	0.487
Smoking behavior	196				
Smoker		Ref.		Ref.	
Ex-smoker		1.12 [0.45; 2.78]	0.806	2.27 [0.61; 8.44]	0.220
Never-smoker		1.19 [0.51; 2.76]	0.693	1.75 [0.55; 5.57]	0.345
BMI [1]	196				
Normal weight		Ref.		Ref.	
Overweight		0.41 [0.17; 1.02]	0.055	0.28 [0.08; 0.99]	0.047
Obesity		0.49 [0.21; 1.14]	0.097	0.29 [0.08; 1.08]	0.066
Chronic diseases [2]					
Baseline diagnosis of hypertension (yes vs. no)	176	0.71 [0.29; 1.76]	0.460	0.49 [0.09; 2.57]	0.400
Baseline diagnosis of diabetes (yes vs. no)	171	1.30 [0.44; 3.83]	0.630	1.55 [0.31; 7.70]	0.592
Baseline diagnosis of dyslipidemia (yes vs. no)	174	1.02 [0.42; 2.47]	0.967	1.11 [0.25; 5.00]	0.895

[1] Body mass index. [2] Self-report of physician's diagnosis. Baseline: prevalence at baseline. Follow-up: incidence since baseline assessment.

4. Discussion

4.1. Main Study Findings and Implications

In this study, four physical activity trajectories ("inactive", "decreasing", "increasing", and "stable active") were identified among a sample of adults of Turkish descent, living in Berlin. Similar results

were reported by Pan et al. who described the same PA trajectories in a Taiwanese sample [26]. Similar trajectories (always sedentary, fast declining, stable moderate, and always active) were reported in a study from the U.S. among a sample of older women aged 70–79 years, however, the authors found no increasing trajectory which was explained with the high age of the study participants [41]. Most studies describe three to four trajectories or patterns [19,26,41], and less often more are reported, as in a European study conducted in Spain with more than 1600 participants, reporting very diversified patterns (high PA—consistent, moderate PA—mildly decreasing, low PA—increasing, moderate PA—consistent, and low PA—decreasing) [12].

The trajectories in our study sample showed differences regarding citizenship, preferred language of the questionnaire, and marital status. Subsequent multivariable regression analyses revealed that being in the stable active trajectory was predicted by only one of the included socio-demographic factors, namely high education (more than 12 years compared to less than 10 years). This is partially in line with several other studies showing that male sex, lower age, high education, and/or a high household income were predictors for favorable PA trajectories (increasing or persistently active) [17,21,33,42–44].

Among the migration-related factors, German or dual citizenship, and German as the preferred questionnaire language were associated with being in the stable active trajectory, while migration generation was not associated. The association with citizenship in our study is in agreement with a previous study from the U.S. showing higher PA among migrants with U.S. citizenship [45]. A recent study from the EU also showed significantly lower PA levels among nationals of non-EU countries in Austria compared to Austrian nationals [46]. Participants who chose German as the questionnaire language were more likely to be in the stable active trajectory, which is supported by a systematic review, including a wide range of countries, showing that poor knowledge of the language of the host country was claimed as having a large impact on PA as a barrier to get access to or understand PA recommendations [29]. Migration generation was not associated with being in the stable active trajectory. Similar results were reported by Koca et al. who investigated PA behavior in Turkish migrants in England and Germany and showed that migration generation and length of stay were not associated with PA. In contrast to our study however, language proficiency was not associated with PA, either [35].

While several studies showed that health-related factors like smoking or high BMI were associated with poor PA outcomes [21,47–50], the results of our study were not that concise. In our study, only overweight and obesity compared to normal weight subjects had decreased odds for being in the stable active trajectory, whereas smoking or having a cardiovascular risk factor were not associated with the PA trajectory. Since the overall prevalence of smokers was fairly high in our sample, this could have attenuated a possible effect of smoking.

Most studies investigating relationships between PA and cardiovascular risk factors focus on PA as exposure, not as an outcome. Common results are that PA leads to a decreased risk of developing cardiovascular risk factors [51,52]. Our results did not show an association of cardiovascular risk factors with future PA, however, the importance of these factors as predictors or mediators for PA should be emphasized. Future studies should include these risk factors as exposure variables when investigating PA trajectories.

4.2. Strengths and Limitations

To our knowledge, this is the first study that investigated physical activity trajectories among a sample of adults with Turkish descent in Germany. A strength of the study was also the application of two different sampling approaches at baseline which led to the inclusion of persons who are generally difficult to reach for participation in epidemiologic studies as well as the intensive retention effort including home visits which contributed to the moderate recruitment success at follow-up. Furthermore, the bilingual questionnaire and staff in the recruitment office and during home visits may have contributed to more valid answers of the participants by reducing possible language or cultural barriers. However, certain limitations of our study need to be considered as well. Despite the moderate

follow-up rate, the total sample size was rather small which may have reduced the statistical power of the study. A relevant selection bias is considered unlikely since baseline PA had a similar distribution in follow-up participants and in non-participants. Further, our analyses allow only the presentation of associations, but we cannot infer causal relationships. Another limitation is that PA was assessed only via self-report. Although the used questions for PA assessment were validated and are components of widely used questionnaires [40], future studies should use accelerometers or other means to objectively measure PA. Moreover, since PA was not the main focus in the used questionnaire, no information about different intensities and settings, nor sedentary behavior could be assessed. With the assessment of moderate-to-vigorous PA and the respective PA durations, we provide, however, the first results regarding PA trajectories for this population group. Future research might address those factors for a more detailed description of long-term PA in persons with a migration background. Lastly, more assessment points would have led to a more precise characterization of the respective PA trajectories. A third assessment is however foreseen.

5. Conclusions

In this study population with adults of Turkish descent in an urban German setting, only 20% of the participants remained physically active over several years. While high education, German citizenship, and good German language skills appeared to initiate healthy PA trajectories, own migration experience seemed to marginally determine motivation for PA. Therefore, linguistic peculiarities should be taken into account when designing culturally adapted lifestyle interventions, particularly for migrants who still hold their original citizenship.

Supplementary Materials: The following are available online at http://www.mdpi.com/1660-4601/17/17/6349/s1, Table S1: Weekly activity levels of PA trajectories and of the total sample (n = 197, complete PA data for baseline and follow-up).

Author Contributions: Conceptualization, L.K. and T.K.; methodology, L.K., T.K., and H.B.; software, L.K. and I.D.; validation, H.B., T.R., and T.K.; formal analysis, L.K.; investigation, L.K.; resources, L.K., C.D., and K.I.; data curation, K.I., C.D.; writing—original draft preparation, L.K. and T.K.; writing—review and editing, C.D., T.R., H.B., K.I., I.D., and S.N.W.; visualization, L.K., T.K., and I.D.; supervision, T.K.; project administration, L.K., T.K., and T.R.; funding acquisition, T.R. All authors have read and agreed to the published version of the manuscript.

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2.1.4. Prädiktoren von Veränderungen körperlicher Aktivität und Sitzverhalten bei Personen mit türkischem Hintergrund während der COVID-19-Pandemie

***Krist L**, Dornquast C., Reinhold T., Icke K., Danquah I., Willich S.N., Becher H., Keil T.:* Predictors of Changes in Physical Activity and Sedentary Behavior during the COVID-19 Pandemic in a Turkish Migrant Cohort in Germany. *Int. J. Environ. Res. Public Health 2021, 18, 9682.*

Die COVID-19-Pandemie und die resultierenden Maßnahmen zur Eindämmung der Virusverbreitung haben zu einer Einschränkung der Sport- und Bewegungsmöglichkeiten geführt. Dies hatte zur Folge, dass eine große Anzahl an Menschen in Deutschland nicht mehr ihren gewohnten Aktivitäten (z.B. Sport, Aktivitäten zur Fortbewegung oder bei der Arbeit) nachgehen konnten. Über die Subpopulation der Personen mit Migrationshintergrund ist diesbezüglich wenig bekannt, da sie in epidemiologischen Studien in Deutschland regelmäßig unterrepräsentiert sind. Das Ziel dieser Studie war es, die Veränderungen des Aktivitäts- und Sitzverhaltens in einer Gruppe türkeistämmiger Berliner darzustellen und Determinanten für eine Verminderung der körperlichen Aktivität bzw. Verlängerung der Zeit, die im Sitzen verbracht wird, zu bestimmen.

Die untersuchte Population bestand aus erwachsenen türkeistämmigen Berlinern, die im Jahr 2011/2012 im Rahmen der Pretests für die NAKO Gesundheitsstudie rekrutiert wurden, um Rekrutierungsstrategien bei Personen mit Migrationshintergrund zu evaluieren. Dieses Sample wurde 2018/2019 erneut befragt. Im Jahr 2020 wurde allen Personen, die einer Rekontaktierung zugestimmt hatten, ein Fragebogen zur Coronapandemie zugesendet, der neben Fragen zu einer möglichen Coronainfektion auch den Einfluss der pandemiebedingten Maßnahmen auf das Gesundheitsverhalten wie körperliche Aktivität oder Sitzen hatte.

Von 377 angeschriebenen Personen beantworteten 106 den Fragebogen (Durchschnittsalter 54±12 Jahre, 58% Frauen). Über zwei Drittel berichteten eine Verminderung der körperlichen Aktivität, während über ein Drittel angab mehr zu sitzen als vor der Pandemie. Mittels multivariabler Regression wurden Prädiktoren für diese Veränderungen untersucht. Prädiktoren für eine verminderte körperliche Aktivität waren das weibliche Geschlecht und körperliche Inaktivität in der Vergangenheit. Diese Faktoren spielten auch für die Veränderung des Sitzverhaltens eine Rolle, jedoch war längeres Sitzen zusätzlich mit höherem BMI assoziiert.

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Predictors of Changes in Physical Activity and Sedentary Behavior during the COVID-19 Pandemic in a Turkish Migrant Cohort in Germany

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Abstract: The new coronavirus (COVID-19) pandemic and the resulting response measures have led to severe limitations of people's exercise possibilities with diminished physical activity (PA) and increased sedentary behavior (SB). Since for migrant groups in Germany, no data is available, this study aimed to investigate factors associated with changes in PA and SB in a sample of Turkish descent. Participants of a prospective cohort study (adults of Turkish descent, living in Berlin, Germany) completed a questionnaire regarding COVID-19 related topics including PA and SB since February 2020. Changes in PA and SB were described, and sociodemographic, migrant-related, and health-related predictors of PA decrease and SB increase were determined using multivariable regression analyses. Of 106 participants, 69% reported a decline of PA, 36% reported an increase in SB. PA decrease and SB increase seemed to be associated with inactivity before the pandemic as well as with the female sex. SB increase appeared to be additionally associated with educational level and BMI. The COVID-19 pandemic and the response measures had persistent detrimental effects on this migrant population. Since sufficient PA before the pandemic had the strongest association with maintaining PA and SB during the crisis, the German government and public health professionals should prioritize PA promotion in this vulnerable group.

Keywords: physical activity; sedentary behavior; COVID-19; migrants; public health

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1. Introduction

In November 2019, the first cases of the new coronavirus Sars-CoV-2 emerged in China. From there, the virus and the coronavirus disease (COVID-19) spread all over the world. In March 2020, the World Health Organization (WHO) declared the COVID-19 outbreak a global pandemic [1]. As of July 2021, more than 180 million cases of COVID-19 had been confirmed by WHO including more than 3.9 million deaths [2].

Many countries have imposed response measures, mostly called 'lockdowns', to contain the spread of the virus including social distancing, home confinement, or closure of public spaces [3]. In Germany, the first case of COVID-19 was detected on 27 January 2020 [4]. As of 22 March 2020, a nationwide lockdown was implemented including the closure of schools, restaurants, bars, sports facilities, and other measures for social distancing such as working from home, wearing masks, prohibition of mass events, as well as the appeal to stay at home whenever possible [5]. These measures were gradually lifted at the

end of May 2020 but had to be reimposed in November–December 2020 during the second wave of the pandemic in Germany [6].

These lockdown measures have influenced people's work, education, travel, and recreation, and subsequently, their levels of physical activity (PA) and sedentary behaviors (SB) all over the world, as two recent reviews show [7,8]. Research shows that physical activity has many positive effects on physical and mental health and can lead to higher social contentedness [9–11]. Additionally, it can help to overcome stress, anxiety, and depressive symptoms, all symptoms that were reported by many persons due to the pandemic [12–14]. Sedentary behavior, on the other hand, is associated with an increased risk of musculoskeletal, metabolic, and cardiovascular diseases [15–17].

Although exercising alone or with one accompanying person was always allowed in Germany, fitness centers, community sports grounds, public swimming pools, and outdoor leisure facilities were closed. Since people were advised to work from home and to stay at home whenever possible, active transport was reduced as well, while the time spent sitting at home increased. As a consequence, many people reduced their activities, especially persons with little children, older adults, as well as persons who did not cope well with the pandemic-induced stress [18–21]. Less is known, however, about coping strategies among migrant groups and if PA and SB changes occurred comparably. There is a study from Australia that investigated coping strategies among migrants during the pandemic, but without taking physical activity into account [22]. A recent study investigating a Turkish migrant sample showed that PA and SB changes depended, among other things, on migration-related factors like citizenship, and the preferred language when completing a questionnaire; however, these results were reported before the COVID-19 pandemic [23].

From a public health perspective, it is important to better understand the underlying mechanisms of PA and SB changes to be able to develop public health strategies for specific population groups that are at higher risk of this undesirable behavior, e.g., due to their living situation, work environment, or language barriers. In Germany, persons with Turkish background have formed the largest migrant group (currently 2.82 million) since in the 1960s and 1970s, when Germany recruited so-called "guest workers" from predominantly Southern Europe and the Mediterranean region [24].

The aim of our study was therefore to describe PA and SB changes during the COVID-19 pandemic in a sample of adults of Turkish descent living in Berlin, Germany, and to investigate sociodemographic, health-related, and migration-related factors associated with those changes.

2. Materials and Methods

2.1. Study Design

This present study is a cohort study among adults of Turkish descent living in the inner-city districts of Berlin. Three assessment points took place in 2011–2012, 2018–2019, and 2020 during the COVID-19 pandemic. The baseline assessment was part of the pretest phase of the German National Cohort (NAKO) intending to evaluate different recruitment strategies (a register-based and a network approach) among persons of Turkish descent using an onomastic procedure. Details of the recruitment are described by Reiss et al. [25].

2.2. Participants and Enrollment

For the baseline assessment, all eligible persons were invited to the study center. Inclusion criteria were having Turkish descent and an age between 20 and 69. Persons who were willing to participate completed a questionnaire and underwent medical examination (measurement of body height and weight, a blood pressure test, had a blood sample taken). After 6 to 7 years (between May 2018 and July 2019), a self-administered questionnaire was sent out to all participants who did not refuse to be recontacted (n = 557). Participants were asked about health status and behavior, health care utilization, among other questions. A description of the follow-up recruitment has been provided by Krist et al. [26]. The 3rd assessment (2nd follow-up) took place during the COVID-19 pandemic between July

and December 2020. A questionnaire, originally used in the German National Cohort (NAKO) [14], including COVID-19 related topics (own infection, living situation, social distancing measures, health behavior, mood since February 2020, the start of the pandemic in Germany) was sent out to all subjects who had not refused to be recontacted since the 1st follow-up (n = 377). The 1st invitation letter was sent out in July, the 1st reminder in August, and the 2nd reminder in November 2020 (Figure 1).

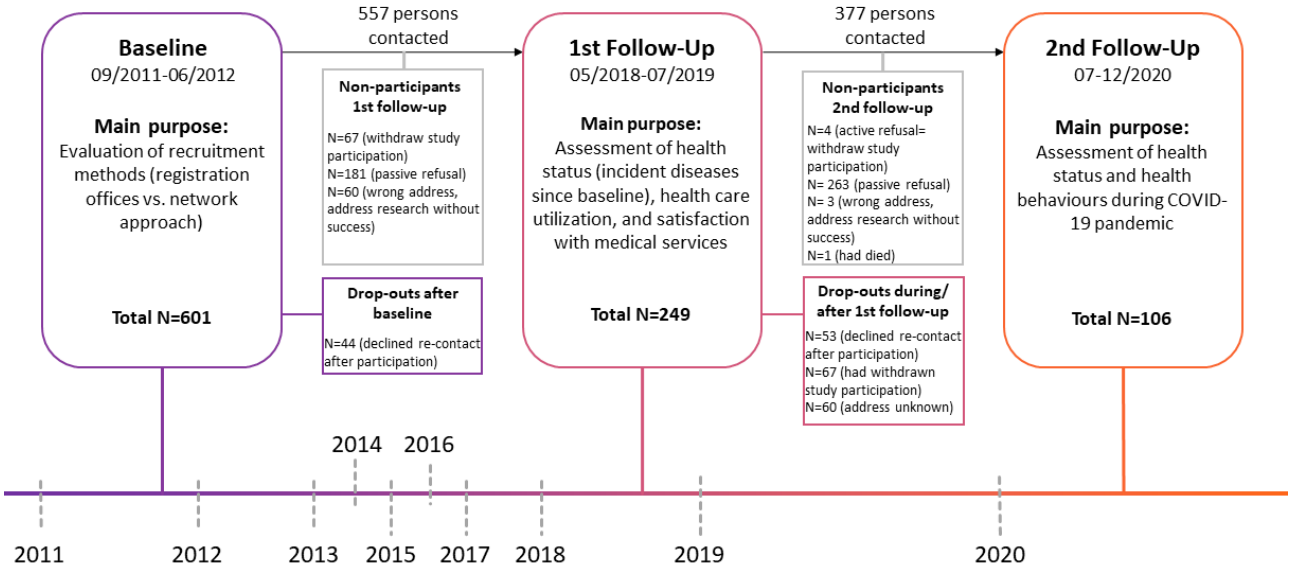


Figure 1. Recruitment process.

Throughout all assessment points, bilingual study material was used to increase participation. The study was approved by the ethical review committee of the Charité—Universitätsmedizin Berlin, Germany, and registered at the German Clinical Trials Register under the registration number DRKS00013545, 08.01.2018. Written informed consent was obtained from all participants.

2.3. Measures

2.3.1. Changes in Physical Activity (PA) and Sedentary Behavior (SB)—Outcome

Changes in physical activity, defined as moderate to vigorous activity, during the COVID pandemic were assessed asking for changes in five different settings: work (working at home counted as working, e.g., carrying loads, walking), home, leisure time, sport, and transport. Another question asked on SB, defined as any activity performed while sitting. For each PA setting as well as for SB, participants could choose between 'much less than before the pandemic', 'somewhat less', 'no change', 'somewhat more', 'much more'. Those five categories were dichotomized into 'less PA' and 'equal or more PA' for physical activity and into 'more SB' and 'equal or less SB' for sedentary behaviors.

2.3.2. Physical Activity as a Covariate

PA was also assessed at 1st follow-up asking for frequency and duration of PA per week. PA minutes were then calculated and dichotomized into at least 150 min or less than 150 min of PA per week according to WHO recommendations [27]. The created variable ('WHO recommendations fulfilled yes/no') was used as a covariate in all analyses.

2.3.3. Sociodemographic Variables

We included age, sex, educational level (assessed at baseline), and employment status (assessed at 2nd follow-up) as sociodemographic variables. Education was assessed as years of education, school type, and country and categorized into <10 years, 10–12 years, and >12 years, taking the Turkish schooling reform into account [28]. We obtained harmo-

nized categories of formal education attained in Turkey and/or Germany. Employment status was assessed as a dichotomous variable yes/no.

2.3.4. Migration-Related Variables

As the first migration-related variable, own migration experience (assessed at baseline) was included. Participants who were born in Turkey or another country were categorized into the group with their own migration experience, while participants who were born in Germany were defined as the group without migration experience.

Second, the language skills of the participants were included using the chosen language of the questionnaire (German or Turkish) since lots of the participants reported two mother tongues (Turkish and German).

2.3.5. Health-Related Variables

As health-related variables, body mass index (BMI), smoking behavior, subjective health status, and mood were included. Body height and weight were measured at baseline by trained study personnel using a calibrated integrated measurement station (SECA model 764, Seca®, Hamburg, Germany). From these measurements, BMI was calculated as weight over height squared in kg/m^2 and categorized into normal weight (BMI 18.5 to < 25.0 kg/m^2), overweight (BMI 25.0 to <30.0 kg/m^2), and obesity (BMI $\geq$ 30.0 kg/m^2). (There was no participant with a BMI below 18.5 kg/m^2.) For the analyses in this manuscript, the BMI of the 1st follow-up was used, calculated using measured height at baseline and self-reported weight at 1st follow-up.

Smoking status was assessed at 2nd follow-up and categorized into smoker (regular smoking), ex-smoker, and never-smoker.

Health status was assessed at 2nd follow-up with the question, 'How would you describe your health status in general?' The answers 'excellent', 'very good', 'good', 'not so good', and 'poor' were dichotomized into 'good' (including 'excellent', 'very good', and 'good') and poor (including 'not so good' and 'poor').

2.3.6. Mental Health Variable

The mood of the participants was assessed at 2nd follow-up as well, using the depression module (PHQ-9) from the Patient Health Questionnaire, a validated 9-item tool for measuring depressive symptoms based on DSM-IV criteria with good test–retest reliability [29]. The questionnaire asks for loss of interest, feelings of depression, tiredness, loss of energy or concentration. Each question had four answer categories: 'Not at all', 'several days', 'more than half the days', and 'nearly every day' resulting in a sum score. The scores ranged from 0 to 27, the cut-off of $\geq$10 points representing moderate to severe levels of depression [30,31].

2.4. Statistical Analyses

We used an explorative statistical approach rather than conducting strict hypothesis testing, as it was not the aim to create a comprehensive prediction model. Participants' characteristics were analyzed using descriptive methods of means and standard deviations for continuous data and absolute and relative frequencies for categorical data. A pairwise correlation analysis was performed to detect relations between the different PA settings that were reported as contingency coefficients (Supplementary Table S1). The settings transport, leisure time, and sports had a contingency coefficient of 0.7 indicating a strong correlation and were subsequently combined to the outcome variable for PA change. Since changes in the settings work and home were less nuanced, they were not included in the main analysis, but only presented in the supplement (Supplementary Table S2). A multivariable logistic regression analysis was conducted to investigate associations between variables assessed at baseline, 1st, and 2nd follow-up (exposures) and changes of PA (combined settings) and SB during the pandemic (outcomes). For the multivariable analyses, covariates with $p > 0.2$ were removed using backward-stepwise elimination (Wald) (i.e., the least significant

covariate was removed one at a time, then the model rerun). The remaining variables of the final model were included in a complete case multivariable logistic regression model. As a measure of goodness-of-fit, we report Nagelkerke's R-squared values. Included variables were not correlated with each other. Results of the multivariable regression analysis were presented as odds ratios (OR) with 95% confidence intervals (CI). The analyses were performed using SPSS Statistics for Windows (25.0.0.1, IBM Corp., Armonk, NY, USA).

3. Results

Out of 377 persons who were contacted between July and December 2020 for the 2nd follow-up of our cohort study, 106 completed the questionnaire (44 after the first invitation, 57 after the first reminder, and 5 after the second reminder). Two hundred and sixty-three persons did not answer, four persons actively declined to participate, three persons could not be reached due to a wrong address, and one person had died.

Among the sample, mean age ± standard deviation (SD) was 53.9 ± 11.8 years, 58% were women, and 82% had their own migration experience. Before the COVID-19 pandemic, 22% were sufficiently active with at least 150 min of moderate PA per week. All participants' characteristics are presented in Table 1.

Table 1. Characteristics of the study sample.

	Men *N* = 44	**Women** *N* = 62	**Total** *N* = 106
	% or mean ± standard deviation		
Sociodemographics			data
Age in years	54.8 ± 10.9	53.2 ± 12.5	53.9 ± 11.8
Educational level [1]			
<10 years	22.7	41.9	34.0
10–12 years	47.7	33.9	39.6
>12 years	27.3	16.1	20.8
Questionnaire language			
German	61.4	48.1	59.4
Turkish	38.6	41.9	40.6
Own migration experience [1]	88.6	77.8	82.0
Employed (half or full time)	54.8	38.3	45.1
Health-related variables			
Body mass index (BMI) [2]	29.7 ± 4.7	29.3 ± 5.3	29.5 ± 5.1
Normal weight (18.5 to <25.0 kg/m^2)	9.7	23.2	18.4
Overweight (25.0 to <30.0 kg/m^2)	41.9	33.9	36.8
Obesity (≥30.0 kg/m^2)	48.4	42.9	44.8
Smoking behavior			
Smoker	34.1	30.0	31.7
Ex-smoker	22.7	28.3	26.0
Never smoker	43.2	41.7	42.3
Physical activity before COVID-19 pandemic [2]			
At least 150 min/week of moderate physical activity	17.6	25.0	22.0
Health status, self-reported			
Good (including good, very good, excellent)	86.4	71.0	77.4
Poor (including less good, poor)	13.6	29.0	22.6
Depressive symptoms (≥10 points on PHQ-9 scale [3])	25.0	34.5	30.5

[1] Variables assessed at baseline (2011/2012); [2] variables assessed at 1st follow-up (2018/2019); [3] PHQ-9: patient health questionnaire depression.

Among all participants, 68.9% reported a decline of PA in any of the five settings (55.6% among the formerly active, and 76.6% among the inactive, (Figure 3a)). The decline was the strongest in sports (55.7%), followed by leisure time PA (43.1%), active transport (42.3%), activities at work (28.3%), and at home (8.1%) (Figure 2). Regarding SB, 36% reported an increase since the start of the pandemic (11.8% among the active, and 46.7% among the inactive) (Figures 2 and 3b).

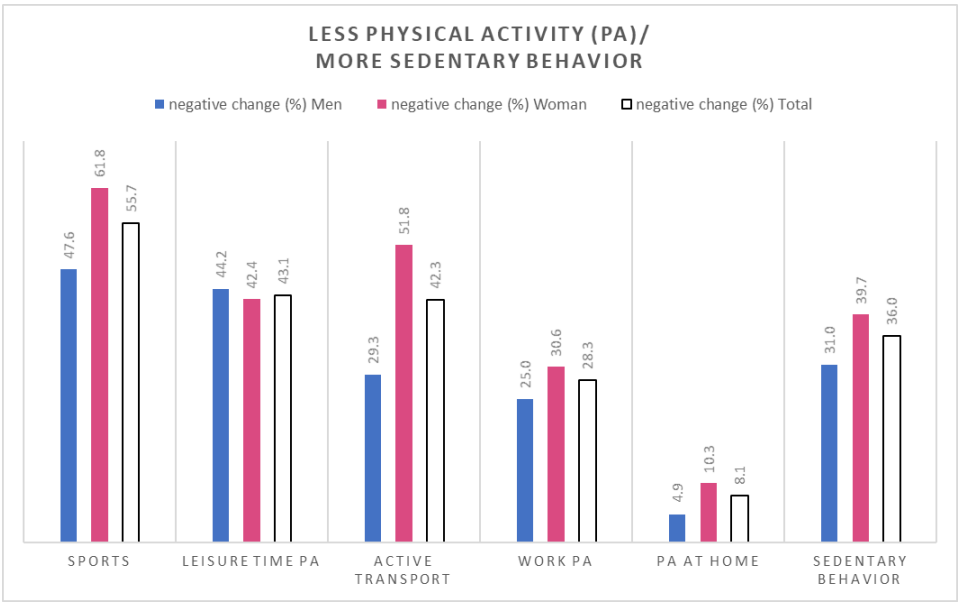
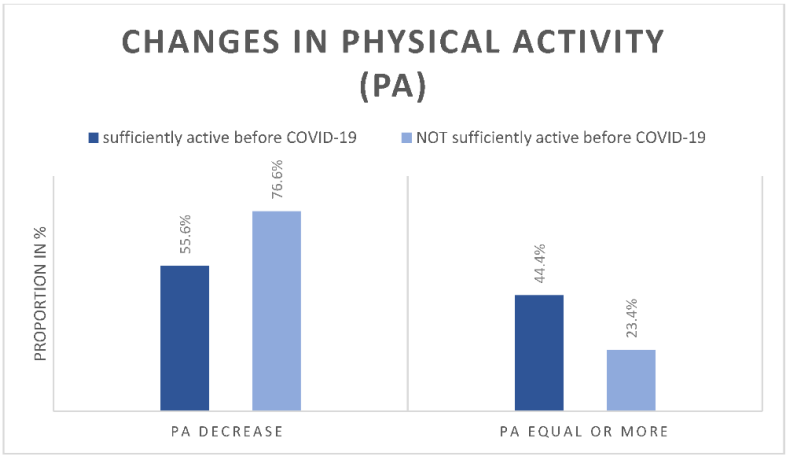
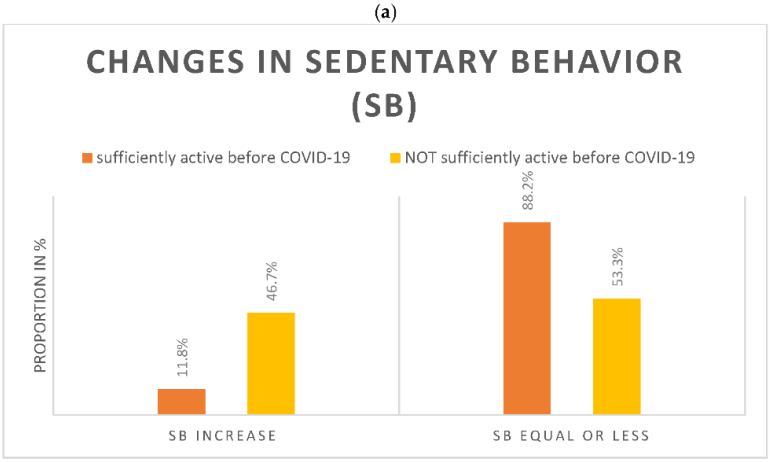


Figure 2. Proportion of participants who reported less physical activity (in five different settings) and more sedentary behavior during the new coronavirus (COVID-19) pandemic (since February 2020) than before.



(**a**)



(**b**)

Figure 3. The proportion of participants reporting (**a**) changes in PA (PA decrease: decrease in any of the 5 PA settings); (**b**) changes in SB. Changes are stratified for having fulfilled WHO recommendations regarding PA before COVID-19.

When stratifying the participants for having fulfilled the WHO recommendations regarding PA (at least 150 min per week at least moderately active) before COVID-19, changes in PA and SB differed between the strata (Figure 3a,b).

Regression Analyses

Univariable regression analysis did not show any statistically significant association between PA changes and the included predictor variables; SB changes were associated with inactivity in the past (Tables 2 and 3).

Table 2. Univariable and multivariable regression analysis for the outcome less physical activity during the COVID-19 pandemic.

Predictors		Less Physical Activity in Transport, Leisure Time, and/or Sports			
		Univariable		Multivariable [4]	
	n	OR (95% CI)	*p*	OR (95% CI)	*p*
Sociodemographics					
Age per year	103	1.0 (1.0;1.1)	0.383	-	
Sex [1]					
Male vs. female	103	0.5 (0.2;1.1)	0.096	0.3 (0.1;0.9)	0.032
Educational level [1]					
<10 years	100	Ref		-	-
10–12 years		2.0 (0.8;5.2)	0.141	-	-
>12 years		1.8 (0.6;5.5)	0.300	-	-
Employed					
No vs. yes	99	0.8 (0.4;1.9)	0.636	-	-
Migration-related variables					
Questionnaire language					
Turkish vs. German	103	1.2 (0.5;2.8)	0.678	-	-
Own migration experience [1]					
No vs. yes	87	2.7 (0.7;10.2)	0.143	-	-
Health-related variables					
Obesity vs. normal/overweight [2]	85	1.3 (0.5;3.2)	0.616	2.0 (0.6;6.9)	0.254
Never/ex-smokers vs. smokers	101	0.6 (0.2;1.4)	0.214	0.4 (0.1;1.4)	0.146
<150 min PA per week vs. ≥150 min PA per week (WHO recommendations)—before COVID-19 pandemic [2]	80	2.6 (0.9;7.8)	0.072	6.2 (1.7;22.6)	0.006
Subjective health status: poor (not so good or poor) vs. good (good, very good, or excellent)	103	0.8 (0.3;2.1)	0.633	0.3 (0.1;1.3)	0.115
Depressive symptoms (≥10 vs. <10 on PHQ-9 scale [3])	95	1.4 (0.5;3.7)	0.487	-	-

[1] Variables assessed at baseline (2011/2012); [2] variables assessed at 1st follow-up (2018/2019); [3] PHQ-9: patient health questionnaire depression. [4] Complete case analysis with remaining variables of the final model of Wald's backward elimination), *n* = 74; Nagelkerke's R-squared: 0.2.

Table 3. Univariable and multivariable regression analysis for the outcome more sedentary behavior during the COVID-19 pandemic.

Predictors		More Sedentary Behavior			
		Univariable		Multivariable [4]	
	n	OR (95% CI)	*p*	OR (95% CI)	*p*
Sociodemographics					
Age per year	100	1.0 (1.0;1.0)	0.467	-	-
Sex [1]					
Male vs. female	100	0.7 (0.3;1.6)	0.371	0.3 (0.1;0.9)	0.040
Educational level [1]					
<10 years	100	Ref		-	-
10–12 years		1.5 (0.6;4.0)	0.393	-	-
>12 years		1.3 (0.4;4.2)	0.610	-	-
Employed					
No vs. yes	96	1.3 (0.5;3.0)	0.575	-	-
Migration-related variables					
Questionnaire language					
Turkish vs. German	100	1.2 (0.5;2.7)	0.682	-	-
Own migration experience [1]					
No vs. yes	84	1.0 (0.3;3.0)	0.957	-	-
Health-related variables					
Obesity vs. normal/overweight [2]	82	1.5 (0.6;3.6)	0.398	3.3 (1.0;10.4)	0.043
Never/ex-smokers vs. smokers	98	1.0 (0.4;2.4)	0.993	-	-
<150 min PA per week vs. ≥150 min PA per week (WHO recommendations)—before COVID-19 pandemic [2]	77	6.6 (1.4;31.2)	0.009	19.3 (2.2;170.0)	0.008
Subjective health status: poor (not so good or poor) vs. good (good, very good, or excellent)	100	1.3 (0.5;3.4)	0.587	-	-
Depressive symptoms (≥10 vs. <10 on PHQ-9 scale [3])	92	2.4 (0.9;5.9)	0.062	-	-

[1] Variables assessed at baseline (2011/2012); [2] variables assessed at 1st follow-up (2018/2019); [3] PHQ-9: patient health questionnaire depression. [4] Complete case analysis with remaining variables of the final model of Wald's backward elimination), *n* = 72; Nagelkerke's R-squared: 0.3.

Multivariable regression analyses revealed that female sex and low PA in the past seemed to be associated with a decreased PA during the pandemic. Women had 70% higher odds than men to engage in less PA during the pandemic (OR 0.3 (0.1;0.9)), and persons who did not fulfill WHO recommendations at 1st follow-up were more than 6 times more likely to report a decrease in PA during the pandemic than their active counterparts (OR (95%CI): 6.2 (1.7;22.6)) (Table 2). Higher SB appeared to be associated with female sex, high BMI, and inactivity in the past. Women had 70% higher odds of sitting more than men (OR 0.3 (0.1;0.9)). Persons who were obese compared to normal or overweight persons were three times, and persons who were not physically active in the past 19 times more likely to sit more during the pandemic (OR: 3.3 (1.0;10.4), and 19.3 (2.2;170.0), respectively) (Table 3).

4. Discussion

The present study aimed to investigate changes in PA and SB among a sample of adults of Turkish descent in Berlin, Germany, during the COVID-19 pandemic, and to determine predictors of these changes.

More than two-thirds of the participants reported a decline in PA since the start of the pandemic, and more than one-third reported an increase in SB. Similar proportions have been suggested by other authors ranging from 40–70%, however, only for non-migrant populations [32,33]. The most important PA decrease was observed in sports, leisure time, and transport, while PA at work decreased moderately and household activities decreased only to a small extent. Since sports facilities were closed and people were advised to stay at home, as well as to work from home, it is comprehensible that PA decreased the most in these three settings and remained almost stable for household activities. A German study supports this assumption by showing that 41% of the participants reported closed sports infrastructure as a reason for reduced PA [21]. Another study from Germany reports similar results for a non-migrant study sample as our study regarding different settings with the highest decrease in sports, leisure time, and work PA, but unchanged household activities [34]. Although our results did not show an association with age, it seems that in younger individuals PA decrease was less nuanced than in older ones. Huber et al. described a decrease of PA in 45% of a sample with a mean age of 23 years [35], and in a German sample of children aged 4 to 17, almost no change of PA was shown; however, screen time increased to a very large extent [36].

The second main finding from our study regards predictors of PA and SB changes. Persons who did not meet the recommendations of being moderately active before the pandemic for at least 150 min per week were more than six times more likely to report decreased PA during the pandemic. This was in line with a study from Italy reporting sufficient activity before the pandemic as one of the predictors to stay active during the pandemic [33]. In contrast, two studies showed a reduction among persons who were active before the pandemic, but not among the inactive [37,38], and a study from the UK reported a reciprocal association between the intensity of PA performed before and its reduction during the pandemic [39]. As reported by several other studies, female sex was also associated with decreased PA in our sample, however, depressive symptoms and health status were not associated, even though 30% of the participants reported depressive symptoms [37,40,41]. Age was not associated with decreased PA either, and neither was education, which is partly in line with another German study that did show an association of higher education with being active during the pandemic, but no association of age and sex, either [18].

Time spent sitting increased in 36% of the participants. This proportion is in the range of 30–50% reported by other authors [33,37,42,43]. A Chinese study reported 67% of persons indicating increased SB; however, the two-to-three month home confinement in China was one of the strictest in the world [44].

Predictors for increased SB were female sex, being obese compared to normal or overweight, and not meeting PA recommendations before the pandemic. This is in contrast to several other studies where SB decrease was rather an overall phenomenon and not

specific for some subgroups [37,43,45]. Among the studies that reported associated factors with SB increase, factors were changes in working situation (working from home or having lost a job) [46], male sex, and non-smoking [47]. While the previous results of this cohort study showed that German citizenship and German as preferred questionnaire language were associated with a positive PA trajectory [23], in the present study none of the migration-related variables was associated with decreased PA or increased SB. Since the results of this study were comparable with other studies conducted in Germany, at least for Berlin there does not seem to be a large difference between the population of origin and persons with a Turkish background.

4.1. Strengths and Limitations

To the best of our knowledge, this is the first study investigating PA and SB changes in persons with a migrant background in Germany during the COVID-19 pandemic. The proportion of studies that focus on migrants is still very small. Especially during a crisis such as the COVID-19 pandemic, it is important to collect data of all relevant subpopulations to be able to react adequately and to inform these subgroups about risks and respective prevention measures during the crisis. Migrants often live in a precarious housing situation, are employed at workplaces where working from home is not possible, or have language difficulties which are barriers to a healthy lifestyle and also risk factors for a coronavirus infection [48]. Therefore, data like ours on preventive lifestyle behaviors is crucial for better preparedness for future pandemics.

The present study will help to provide information about the health behavior of Turkish migrants in Germany and could thus be used to address this population group more individually. Another strength of our study was that PA behavior before the pandemic was assessed before and not as recall during the already existing pandemic. Third, data collection started six months after the start of the response measures including the summer with only a few restrictions and the autumn/winter where a nationwide lockdown was reimposed. These data represent therefore a more realistic and long-term effect of the pandemic and the restrictions on changes in PA and SB. Apparently, reduction of PA and increase of SB are not only an acute problem during a lockdown but continue even if response measures have been lifted.

Among the limitations of our study, we need to point out that the number of participants decreased considerably after the baseline assessment. Differences between participants and non-respondents may have led to somewhat distorted results. However, since unfavorable health behaviors were more common among non-respondents than among participants, changes in PA and SB were rather under- than overestimated. This assumption is supported by Wunsch et al., who investigated the effects of the pandemic on PA changes as well, performing a non-respondents' analysis and showing lower PA and higher SB at baseline among the non-respondents compared to the respondents [49]. Another limitation is reduced significance of the study due to the small sample size. A further limitation is the limited comparability of studies from different countries focusing on this topic. While some countries such as China, Italy, or France imposed home confinements and strict curfews, the measures in Belgium, Switzerland, and Germany were less drastic. Lastly, a self-administered questionnaire has its limitations and increases the risk of response bias due to social desirability or recall difficulties, even if the questions were taken from validated questionnaires [50,51].

4.2. Implications

Our results emphasize the importance of providing possibilities to maintain PA even during a crisis like the COVID-19 pandemic. A recent review showed evidence of the benefits of exercise programs designed to motivate people during a home confinement, including reducing their feeling of loneliness, e.g., online training programs, exergames, programs for the whole family/household, activities at home, or use of fitness trackers [52]. WHO, the American Heart Association (AHA), and the American College of

Sports Medicine (ACSM) offered guidelines regarding activities during home confinement [53–55], but these associations are, however, not very well known in Germany. In addition, persons with lower socioeconomic status including a considerable number of migrants with a Turkish background are already less likely to engage in sufficient physical activity [56,57]. Besides financial barriers and the accessibility of sports facilities, gender roles, social expectations, language problems, as well as religious aspects influence the engagement in PA [58]. Exercise promotion in Germany is already very limited in normal times, therefore, after this global health crisis, essential government actions should be the implementation of nationwide exercise programs and information campaigns regarding health benefits of PA and strategies to reduce SB. In addition to general prevention measures, special emphasis should be put on more personalized programs, as proposed by the investigators of the DEDIPAC study [59], targeting vulnerable persons, such as persons with low socioeconomic status, or migrants and their descendants. These could be peer-supported programs promoted in the respective migrant communities [60].

5. Conclusions

Our study provides evidence of persistent lifestyle behavioral consequences of the COVID-19 pandemic, demonstrating an adverse effect on PA and SB among a sample of adults with Turkish roots living in Germany. Among this sample, PA was a strong predictor for staying active during this pandemic crisis. These findings highlight the importance of PA promotion efforts, but not only specific to the pandemic situation, where sports facilities were less accessible, and people were staying most of the time at home.

Supplementary Materials: The following are available online at https://www.mdpi.com/article/10.3390/ijerph18189682/s1, Table S1: Contingency coefficients of different physical activities, Table S2: Factors associated with reduced physical activity (PA) and/or increased sedentary behavior (SB). Univariable regression analysis. Outcome: Less activity/more sedentary behavior.

Author Contributions: Conceptualization, L.K. and T.K.; methodology, L.K.; validation, T.K., T.R.; formal analysis, L.K., K.I.; investigation, L.K.; resources, L.K.; data curation, K.I.; writing—original draft preparation, L.K.; writing—review and editing, T.K., T.R., C.D., K.I., I.D., H.B., S.N.W.; visualization, L.K.; supervision, T.K.; project administration, T.R., T.K.; funding acquisition, T.R. All authors have read and agreed to the published version of the manuscript.

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Institutional Review Board Statement: The study was approved by the ethical review committee of the Charité—Universitätsmedizin Berlin, Germany, and registered at the German Clinical Trials Register under the registration number DRKS00013545.

Informed Consent Statement: Informed consent was obtained from all subjects involved in the study.

Data Availability Statement: The datasets used for this study are available from the corresponding author on reasonable request.

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Conflicts of Interest: The authors declare no conflict of interest.

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2.2. Präventive altersspezifische Interventionsmaßnahmen am Beispiel von körperlicher Aktivität und Tabakkonsum

2.2.1. Progressives Krafttraining zur Mobilitätssteigerung bei Hochaltrigen

***Krist, L.**, Dimeo, F., Keil, T.:* Can progressive resistance training twice a week improve mobility, muscle strength, and quality of life in very elderly nursing-home residents with impaired mobility? A pilot study. *Clin Interv Aging. 2013;8:443-8.*

Mit steigendem Alter nimmt die Muskelmasse beim Menschen deutlich ab. Dieser Muskelabbau erhöht das Risiko für Stürze, kann zu Schwierigkeiten bei der Bewältigung von alltäglichen Aktivitäten und zu Pflegebedürftigkeit führen. Studien konnten zeigen, dass Krafttraining auch im hohen Alter noch positive Effekte beim Muskelaufbau erzielt. Die vorliegende Studie hat untersucht, inwiefern mit zweimal pro Woche durchgeführtem Krafttraining bei hochaltrigen Pflegeheimbewohnern eine Kraftsteigerung und eine verbesserte Mobilität erreicht werden kann.

Dazu wurden aus verschiedenen Pflegeheimen in Berlin insgesamt 15 Teilnehmer und Teilnehmerinnen rekrutiert. Sie waren in ihrer Mobilität eingeschränkt, hatten jedoch keine schweren Vorerkrankungen, die eine Teilnahme an dem Krafttraining ausgeschlossen hätten. Die Teilnehmenden waren zwischen 77 und 97 Jahre alt (Durchschnittsalter 84 Jahre) und wiesen einen durchschnittlichen Mobilitätswert von 14 Punkten auf der Elderly Mobility Scale auf (0 entspricht dabei dem niedrigsten, 20 dem höchsten Wert). Sie absolvierten zweimal pro Woche ein 8-wöchiges angeleitetes Krafttrainingsprogramm an verschiedenen Geräten im Fitneßstudio sowie Bauchmuskelübungen auf der Matte.

Nach den 8 Wochen zeigte sich für jede Person sowohl individuell eine Verbesserung der Kraft und der Mobilität als auch ein durchschnittlicher Anstieg des Mobilitätscores auf 17 Punkte für die Studienpopulation. Das maximale Gewicht an den Geräten bzw. die Wiederholungszahl bei der Bauchmuskelübung war ebenfalls nach 8 Wochen bei allen Personen gestiegen.

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ORIGINAL RESEARCH

Can progressive resistance training twice a week improve mobility, muscle strength, and quality of life in very elderly nursing-home residents with impaired mobility? A pilot study

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Purpose: To determine the effects of progressive resistance training on mobility, muscle strength, and quality of life in nursing-home residents with impaired mobility.

Methods: Nursing-home residents aged 77 years and older with impaired mobility were recruited in Berlin, Germany. The eight-week exercise program consisted of progressive resistance training twice a week. Mobility (primary outcome) was assessed with the Elderly Mobility Scale (zero = worst, 20 = best) at baseline and after 8 weeks. Muscle strength (secondary outcome) was determined by the eight-repetition maximum. The Short Form-36 Health Survey was used to assess quality of life.

Results: Of the 15 participants (mean age 84 years, range 77–97 years), ten completed the 8-week program. Mobility (Elderly Mobility Scale mean ± standard deviation pre 14.1 ± 3.2 and post 17.5 ± 3.6; $P = 0.005$) as well as muscle strength of upper and lower limbs improved (from 62% at chest press up to 108% at leg extension machine), whereas most quality of life subscales did not show considerable change.

Conclusion: Resistance training twice a week over 2 months seemed to considerably improve mobility and muscle strength in persons aged 77–97 years with impaired mobility.

Keywords: elderly, resistance training, mobility, muscle strength, nursing home

Introduction

Advancing age is related to considerable changes in mental and physical health, including loss of muscle mass (sarcopenia) and muscle function. This can lead to impaired physical ability and reduced quality of life.[1–3] After the age of 70 years, about 1.5% of muscle mass is lost per year.[4] Denervation, metabolic, hormonal, or immunological reasons and the reduction of physical activity, in particular, contribute to sarcopenia.[5] However, muscles can maintain a high degree of plasticity in advanced age, whereas tendons lose their plasticity predisposing them to injuries.[6] Resistance training may reverse tendon stiffness and reduce the risk of strain injuries. Furthermore, it can increase muscle strength and improve mobility as well as physical functioning in the elderly.[7]

Several studies have investigated exercise programs for the very elderly and found moderate to very high improvements in muscle strength, balance, gait speed, and other outcomes that are indispensable for an independent life.[8–10] However, most studies examined healthy and community dwelling elderly,[11–13] whereas persons with impaired physical ability as well as nursing-home residents or persons in long-term care facilities were underrepresented.[14]

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A recent systematic review on the effects of progressive resistance training in elderly nursing-home residents showed that the intensity of the training should be vigorous and the duration at least 2 months.[15] Most authors describe a frequency of three training sessions per week, but the optimal frequency has not been defined.[16–19]

Therefore, the aim of this study was to investigate how much progressive strength training twice a week over a period of 8 weeks improves mobility, muscle strength, and quality of life in nursing-home residents with impaired mobility aged 75 years and older.

Methods

Subjects and recruitment

Between May and July 2009, 34 nursing homes in Berlin were contacted by phone. Out of the twelve that agreed to have a personal meeting with more detailed information, seven homes were excluded due to lack of interest in participation, residents without impaired mobility, or residents were looked after by a legal guardian. Five homes were included in the current study.

Nursing-home residents were included if they fulfilled all of the following criteria: (1) 75 years of age and older; (2) mild to severely impaired mobility defined as an Elderly Mobility Scale (EMS) score between six and 18 points; (3) sufficient language skills; (4) written informed consent; and (5) written consent by their general practitioner. Exclusion criteria were: (1) moderate to severe dementia (Mini-Mental State Examination $<$ 18 points;[20] (2) rheumatologic, orthopedic, or any other condition that could be aggravated by sport; (3) elevated systolic/diastolic blood pressure during exercise ($>$230/110 mmHg); (4) cardiac arrhythmia; (5) epilepsy; or (6) legal care. The ethical review committee of the Charité University Medical Center (Berlin, Germany) approved the study.

Interventions

Participants underwent a progressive resistance training program twice a week for 8 weeks using the following six gym machines: chest press, rowing machine, and butterfly reverse for the upper limb, leg press and leg extension for the lower limb, and a crunch trainer for the abdominals (gym80 International GmbH, Gelsenkirchen, Germany). Training was performed in three sets of eight repetitions of the individual lifted weight. Between the sets, participants had to pause for at least 1 minute. Total training duration was 45 minutes. At the beginning, all participants received an individual detailed introduction at each gym machine by qualified fitness trainers. The 15 participants were divided into two groups, which trained separately and were supervised by the trainers and the study investigator throughout the program. At each machine, height and angle of the seat were adjusted to the individual needs of the participant. Participants who needed help to get on the seat were supported by the training staff. Sitting height and position as well as velocity and range of movements at each machine were checked throughout the exercise by the trainers. The lifted weight was set by the training staff, documented, and regularly adapted to the augmented muscle strength of participants. As soon as a participant could lift the weight more than eight times in a row in all of the three sets, the weight was increased to the next level. Depending on the machines, weight increments ranged from 5–10 kg. Every deviation of regular training was documented. Water was offered to participants ad libitum.

Outcomes

Primary outcome of the study was the change in mobility determined by the standardized and validated EMS, a seven-item instrument with a good sensitivity and practicability, assessed by the study physician. The score ranges from zero (minimal mobility) to 20 (maximal mobility).[21–23]

Secondary outcomes were changes in muscle strength and quality of life. They were measured before and after the training intervention. Muscle strength was measured indirectly by documenting the respective lifted weight. For the assessment of quality of life, the Short Form-36 Health Survey (SF-36) was used.[24]

All participants underwent a short medical exam including a resting electrocardiogram in the Department of Sports Medicine at the Charité University Medical Center. In the gym, the trainers determined the individual eight-repetition maximum, defined as the highest weight that a participant can lift a maximum of eight times in a row. It is comparable to 80% of the one-repetition maximum (the highest weight a person can lift only once). The latter was not used due to a higher risk of causing blood pressure peaks in comparison to the eight-repetition maximum. During this introductory exercise, blood pressure was measured after every weightlifting series at each machine to detect potential blood pressure peaks.

All participants received a free 3-monthly membership for the gym including insurance, which covered possible accidents occurring during the stay at the gym.

During transportation from the nursing home to the gym, they were insured by a private transportation company.

Statistical analysis

This study was planned as a pilot study without a priori sample size estimation. A pre–post comparison of assessed outcomes (mean ± standard deviation) was carried out by the Wilcoxon signed-rank test for paired samples. The alpha-type error was set at 0.05, with a power of 80%. Data analysis was conducted with SPSS 12.0.0 (SPSS Inc, Chicago, IL, USA). The outcome variables mobility and muscle strength were assessed as continuous variables from zero (minimum) to 20 (maximum EMS score) and lifted weight in kilograms, respectively. Quality of life was measured as a continuous variable from zero to 100 points.

Results

Recruitment and baseline characteristics

Fifteen nursing-home residents aged 77–97 years (mean age 84 years) were recruited. In the current analysis, ten participants who completed the 8-week program were included: four men (mean age 88 years, range 80–95 years) and six women (mean age 81 years, range 77–87 years). During the course of the 8 weeks, three men and two women dropped out of the study for the following reasons: back pain, which was not related to the intervention; depression; insufficient adjustment of insulin therapy to the exercise program; broken foot (at the nursing home); ripped catheter during changing of clothes before the training. The five participants who dropped out were comparable in age, sex, and body mass index to the ten participants who completed the 8 weeks of intervention, with an average of 15/16 completed sessions (Table 1).

Table 1 Baseline characteristics of participants and dropouts (n = 15)

Variable	Participants (n = 10)	Dropouts (n = 5)
Sex		
Men (n)	4	2
Women (n)	6	3
Age, years	84.1 ± 5.7	84.6 ± 7.4
Anthropometry		
Body weight, kg	71.6 ± 14.8	66.3 ± 13.0
Body mass index, kg/m^2	25.8 ± 5.1	24.7 ± 4.1
Mental status		
Cognitive function: score of MMSE†	27 ± 3	26 ± 3
Depression: score of GDS‡	8 ± 5	12 ± 7

Notes: †Maximum: 30 points; ‡0–5 indicates normal mood, 6–11 indicates mild, and 12–30 indicates manifest depression; data represents mean ± standard deviation unless otherwise stated.

Abbreviations: GDS, Geriatric Depression Scale; MMSE, Mini-Mental State Examination.

Outcomes

After the 8-week intervention, mobility improved by 24% ($P = 0.005$; Table 2). The effect was larger in men compared to women (27% versus 21%): baseline EMS scores of 14 versus 18 and 15 versus 18 after 8 weeks for men and women, respectively. Mobility increased in every individual participant (Figure 1). Muscle strength (eight-repetition maximum) increased at every machine (Table 2). At the rowing machine and the leg extension machine, the lifted weight was doubled. The number of sit-up repetitions increased fourfold (pre 10.5 ± 3.1, post 41.7 ± 12.1 repetitions; $P = 0.027$). Women showed a higher improvement in the eight-repetition maximum, particularly at the rowing machine and leg extension (Figure 2).

After the 8-week training program, quality of life did not change considerably regarding both the physical and emotional sum scales of the SF-36: pre 30/100, post 30/100 and pre 59/100, post 56/100 ($P = 0.29$), respectively. There were also no relevant improvements regarding the subscales of the SF-36 except for the subscale of physical functioning, which slightly improved (pre 27/100, post 32/100; $P = 0.54$).

Discussion

Main findings

This pilot study represents an approach to the development of an exercise program focused on the elderly. The progressive resistance program with two sessions per week over a period of 8 weeks improved mobility and muscle strength in nursing-home residents over 75 years of age with impaired mobility. Overall quality of life did not change after the 2-month program.

Comparison with other studies

This study showing that progressive resistance training increases muscle strength confirmed results from previous studies such as the randomized controlled trial by Ferri et al who trained participants aged 65–81 years at 80% of the one-repetition maximum with knee extension machines. The one-repetition maximum increased as well as the cross-sectional muscle area.[25] Rosendahl et al showed positive effects of 3 months resistance training (eight to twelve-repetition maximum) in participants with a mean age of 84 years, which were still present after 6 months.[26]

Resistance training programs for nursing-home residents with a high-intensity program (eight-repetition maximum or

Table 2 Changes in mobility and muscle strength in ten participants who completed the resistance training program

Variable	Baseline	8 weeks	*P*-value	Mean of difference (8 weeks versus baseline)	
				Absolute	%
Mobility					
Score on Elderly Mobility Scale	14.2 ± 3.4	17.5 ± 3.6	**0.005**	3.3 ± 0.9	24% ± 8%
Muscle strength (eight-repetition maximum)					
Chest press, kg	17.0 ± 7.9	27.5 ± 10.6	**0.005**	10.5 ± 5.0	62%
Rowing machine, kg	17.0 ± 9.8	33.5 ± 12.0	**0.005**	16.5 ± 7.1	97%
Butterfly reverse, kg	14.5 ± 6.4	24.5 ± 10.9	**0.008**	10.0 ± 7.0	74%
Leg press, kg†	35.2 ± 15.4	63.7 ± 25.9	**0.007**	28.4 ± 15.0	81%
Leg extension, kg	13.0 ± 7.5	27.0 ± 10.6	**0.005**	14.0 ± 6.1	108%

Notes: †Only nine participants could perform this exercise; data represents mean ± standard deviation; bold indicates statistical significance (alpha-type error set at 0.05).

80% of the one-repetition maximum), as used in the current study, seem to be the most effective method to increase muscle strength.[15,17–19,26,27] However, the strong positive effect in muscle strength improvement shown in the current study was in accordance with only one of these studies,[17] whereas the other studies showed smaller effects on muscle strength.[18,19,26]

Regarding training frequency, sessions offered three times a week were used most often in studies focusing on the elderly.[14,15] In contrast to this approach, the current study examined a training program with only two sessions per week and was able to show even stronger effects than in comparable studies.[27,28]

Training duration did not seem to have a comparable influence as training intensity. Latham et al showed an effect size difference of 0.15 between short (≤12 weeks) and long training duration (>12 weeks) in 41 trials with 1955 participants aged 60 years and over.[14] As in the current study, most interventions had a duration of 8–12 weeks.[18,19,27,29]

Progressive resistance training improves not only muscle strength and mobility but also physical abilities, including simple and more complex daily activities in the elderly. However, there is insufficient evidence on long-term effects as concluded by the authors of a Cochrane review.[30]

Overall quality of life, shown with the physical and emotional sum scale of the SF-36, did not improve in the current study. It is assumed that the 8-week duration of the intervention was too short to detect considerable changes in quality of life. Furthermore, the structure of the SF-36 may have been too complex for this age group (eg, heterogeneity of answering categories). Interviews had to be conducted with some participants who were not able to read the questionnaire by themselves.

A shorter questionnaire with simpler answering categories such as the SF-12 may be an alternative to assess quality of life in future studies with the elderly.[31]

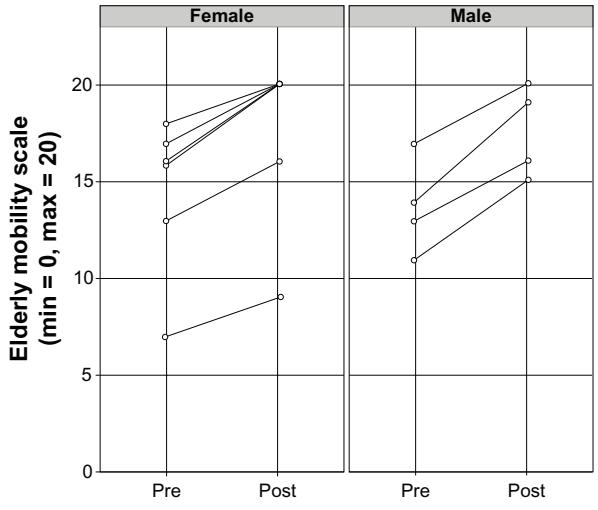

Figure 1 Individual improvement of mobility score on the Elderly Mobility Scale before and after training intervention for women (n = 6) and men (n = 4).

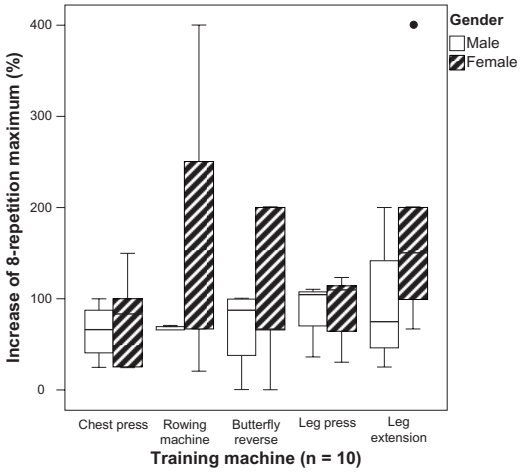

Figure 2 Comparison of percentage increase in eight-repetition maximum for each training machine for male (n = 4) and female (n = 6) study participants.
Notes: Horizontal line in the box represents the median; lower and upper end of the box represents the 25th and 75th percentile, respectively; maximum length of each whisker represents 1.5 times the interquartile range; dot represents the outlier.

Strengths and limitations

A particular feature of this study was the investigation of very elderly nursing-home residents with impaired mobility who have hardly been included in intervention studies as shown by the review of Valenzuela.[15] A strength of this study was the use of validated instruments like the EMS and the SF-36.[22,24]

Several potential limitations have to be considered when interpreting the results of this pilot study. Due to the lack of a control group, the possibility that other factors in addition to the resistance program contributed to the improved mobility and muscle strength cannot be ruled out. Furthermore, familiarization with the gym equipment may have contributed to the training effect, since most participants were not used to resistance training in a gym. The small study population of this investigation cannot be considered as representative for nursing-home residents in Berlin. Most contacted homes were not interested in an exercise program for residents with impaired mobility. For safety and legal considerations, several inclusion and exclusion criteria had to be defined in order not to put participants at risk and aggravate preexisting diseases. Persons under legal care (about 80% of nursing-home residents) were not eligible and were therefore not included in the study. Although several study participants dropped out, two-thirds completed the 8-week intervention, showing the feasibility of this resistance program in persons up to almost 100 years of age with impaired mobility.

Conclusion

A progressive resistance training program only twice a week over a period of 8 weeks seems to be a beneficial intervention to improve mobility and muscle strength in nursing-home residents with impaired mobility aged up to 97 years. The intervention did not seem to influence quality of life as assessed by the SF-36 over the 2-month study period; however, it cannot be excluded that a longer intervention may have beneficial effects on quality of life as well.

Randomized controlled trials evaluating the benefits of resistance training in frail nursing-home residents are urgently needed. In these trials, the setting should be adapted and implementable in the daily routine of the elderly regarding intensity, duration, and frequency of the training; special attention should be paid to a presumably high dropout rate due to multimorbidity.

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Disclosure

The authors report no conflicts of interest in this work.

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2.2.2. Langzeiteffektivität eines Interventionsprogramms zur Rauchprävention bei Siebtklässlern

***Krist, L.**, Lotz, F., Bürger, C., Ströbele-Benschop, N., Roll, S., Rieckmann, N., Müller-Nordhorn, J., Willich, S.N., Müller-Riemenschneider, F.:* Long-term effectiveness of a combined student-parent and a student-only smoking prevention intervention among 7th grade school children in Berlin, Germany. *Addiction. 2016;111(12):2219-29. https://doi.org/10.1111/add.13537*

Die Raucherprävalenz bei deutschen Jugendlichen ist eine der höchsten in Europa. Bezüglich des Nichtraucherschutzes bildet Deutschland das Schlusslicht im europäischen Vergleich. Es werden weiterhin zu wenig Maßnahmen zur Prävention des Rauchens angeboten. Das Ziel dieser Studie war es daher, eine entsprechende Präventionsmaßnahme zu entwickeln und diese in einer randomisierten Interventionsstudie zu evaluieren.

In einem dreiarmigen clusterrandomisierten Studiendesign wurden 47 Schulen mit insgesamt 161 Klassen und 2.801 Schülerinnen und Schülern der 7. Klasse eingeschlossen. Eine Gruppe erhielt eine Präventionsmaßnahme für die Kinder (Absolvierung eines Lernparcours), die zweite Gruppe erhielt eine Kombination bestehend aus der Maßnahme für die Kinder und einer Maßnahme für die Eltern (Aufklärung, Diskussion), die dritte Gruppe diente als Kontrollgruppe und absolvierte einen Lernparcours zu einem anderen Gesundheitsthema (Ernährung und Bewegung). Zusätzlich wurden alle Schüler regelmäßig befragt (Erstbefragung in der 7. Klasse parallel zur Intervention sowie zwei weitere Befragungen in der 8. und 9. Klasse). Der primäre Endpunkt war regelmäßiges Rauchen (mindestens eine Zigarette pro Tag) 24 Monate nach der Intervention.

In den beiden Interventionsgruppen war der Anteil der regelmäßigen Raucher 24 Monate nach der Intervention etwas niedriger als in der Kontrollgruppe. Die Analyse des Risikos für regelmäßiges Rauchen ergab jedoch keine statistisch signifikante Reduktion weder für die kombinierte Interventionsgruppe oder die Schülerintervention im Vergleich zur Kontrollgruppe noch für die kombinierte Intervention im Vergleich zur Schülerintervention.

3. Diskussion

3.1. Determinanten für körperliche Aktivität und sitzendes Verhalten in urbanen Settings

3.1.1 Jugendliche

In der vorliegenden Arbeit zu körperlicher Aktivität bei Jugendlichen konnte gezeigt werden, dass nur knapp 13% der Siebtklässler die WHO-Empfehlungen bezüglich körperlicher Aktivität (mind. 60 Minuten pro Tag) erfüllten. Mehr Jungen (15,9%) als Mädchen (9,8%) erfüllten diese und waren auch länger aktiv als die Mädchen (0,9 Stunden im Gegensatz zu 0,6 Stunden). Dagegen verbrachten Jungen mehr Zeit vor dem Bildschirm (3,9 Stunden pro Tag vs. 3,1 bei Mädchen). Über 80% der Jungen und zwei Drittel der Mädchen verbrachten mehr als 2 Stunden pro Tag mit Bildschirmzeit. Bei der Zweitbefragung nach zwei Jahren war der Anteil an aktiven Jugendlichen (mittlerweile Neuntklässler) noch weiter gesunken (9%) und der Anteil derjenigen, die mehr als 2 Stunden täglich vor dem Bildschirm verbrachten, war von 75% auf 80% gestiegen. Prädiktoren für einen positiven Verlauf (Aufrechterhaltung bzw. Steigerung) der körperlichen Aktivität über die zwei Jahre war allein das männliche Geschlecht. Prädiktoren für eine positive Entwicklung der Bildschirmzeit (gleichbleibend oder weniger) war das weibliche Geschlecht, ein hoher Sozialstatus und der Besuch eines Gymnasiums im Gegensatz zu einer Integrierten Sekundarschule.

Die Ergebnisse verdeutlichen darüber hinaus die Komplexität der Determinanten für körperliche Aktivität und Bildschirmzeit. In der untersuchten Gruppe der Jugendlichen konnte gezeigt werden, dass individuelle Faktoren wie das Geschlecht und der BMI, aber auch gesellschaftliche Faktoren wie der sozioökonomische Status (SES) der Familie sowie des Wohnumfeldes und der Schultyp mit dem Ausmaß an körperlicher Aktivität und Bildschirmzeit assoziiert sind. Da einige dieser Faktoren, wie beispielsweise Schultyp und individueller SES, miteinander assoziiert sein können, ist es teilweise schwierig, die Stärke oder den Anteil zu bestimmen, den die Faktoren an der Assoziation mit körperlicher Aktivität oder Bildschirmzeit haben.

Körperliche Aktivität

Während die Assoziation von männlichem Geschlecht und niedrigem BMI mit mehr körperlicher Aktivität in vielen Studien gezeigt werden konnte [102,103], ist die Studienlage zu SES und Schultyp weniger einheitlich. Der Sozialstatus scheint zwar positiv mit der Teilnahme an organisiertem Sport, z.B. im Verein, assoziiert zu sein, gleichzeitig aber wenig Einfluss auf die Gesamtaktivität von Jugendlichen zu haben [104,105]. Allerdings gibt es Unterschiede bei der

Auswirkung des SES auf körperliche Aktivität bei Mädchen und Jungen. So sind männliche Jugendliche häufiger auch unabhängig von ihrem Sozialstatus körperlich aktiv, während bei Mädchen diejenigen mit hohem Sozialstatus deutlich häufiger aktiv sind als Mädchen mit mittlerem oder niedrigem Sozialstatus [106,107]. Ein weiterer Grund für den Unterschied zwischen dem Aktivitätsverhalten von Mädchen und Jungen könnte das Ungleichgewicht an männlichen Vorbildern im Sport (z.B. die Fußballnationalmannschaft) im Vergleich zu weiblichen Vorbildern sein [108].

Schulen mit niedrigerem Anforderungsprofil (in Berlin sind dies die sogenannten Integrierten Sekundarschulen – im Gegensatz zu Gymnasien) sowie ein niedriger SES im Umfeld der Jugendlichen scheinen körperliche Aktivität zu begünstigen, wobei sich diese beiden Faktoren gegenseitig bedingen können. Auch ist es möglich, dass weniger Hausaufgaben und ein niedrigerer Leistungsanspruch zu mehr Freizeit und damit zu mehr körperlicher Aktivität führen [109].

Es konnte gezeigt werden, dass von Kindern mit Migrationshintergrund der organisierte Vereinssport weniger in Anspruch genommen wurde, die Gesamtaktivität der Jugendlichen jedoch nicht mit einem bestehenden Migrationshintergrund assoziiert war [110]. Es ist daher nachvollziehbar, dass es in den vorliegenden Studien keine Assoziation mit migrationsbezogenen Variablen gab, da nur die Gesamtaktivität betrachtet wurde.

Bildschirmzeit

Bei Betrachtung der Bildschirmzeit konnte gezeigt werden, dass männliche sowie übergewichtige oder adipöse Jugendliche mehr Zeit am Bildschirm verbringen als weibliche oder normalgewichtige Jugendliche. Dies entspricht den Ergebnissen anderer Studien, allerdings ist das sitzende Verhalten insgesamt bei Mädchen höher als bei Jungen, weshalb eine Differenzierung in unterschiedliche sitzende Tätigkeiten sinnvoll erscheint [111–113].

Im Gegensatz zur körperlichen Aktivität gibt es klarere Assoziationen mit dem individuellen und Umfeld-SES, wobei ein niedrigerer SES mit mehr Bildschirmzeit verbunden ist. Dieser Zusammenhang zeigte sich in diversen Studien und wird vor allem mit dem Bildungsstand der Eltern und mit ihrem Rollenbild erklärt [105]. Gebildete Eltern sind sich der schlechten Konsequenzen von übermäßigem Medienkonsum bewusst und haben daher oft strengere Regeln, was die Bildschirmzeit angeht [114]. Kinder aus Haushalten mit niedrigerem Sozialstatus haben darüber hinaus häufiger einen Fernseher in ihrem Zimmer und schauen auch häufiger zusammen mit den Eltern fern [115]. Die Bildschirmzeit der Kinder ist umso niedriger, je weniger Zeit die Eltern selbst am Bildschirm verbringen und je aktiver sie sind und so ihren Kindern alternative Beschäftigungen vorleben [116,117].

Sowohl in der vorliegenden Quer- als auch Längsschnittstudie zeigten Schüler der Integrierten Sekundarschulen mehr Bildschirmzeit als Gymnasiasten. Dies konnte in anderen Studien

bestätigt werden [118,119]. Ein Grund hierfür könnte neben mehr Freizeit durch weniger Leistungsanforderung wiederum die Korrelation mit dem SES sein, außerdem besuchten etwas mehr Jungen als Mädchen die Integrierten Sekundarschulen.

3.1.2 Personen mit türkischem Hintergrund

Körperliche Aktivität im Zeitverlauf

Die vorliegende Arbeit konnte zeigen, dass bei Erwachsenen mit türkischem Migrationshintergrund neben einer höheren Bildung und einem niedrigen BMI auch deutsche Sprachkenntnisse und die deutsche Nationalität mit einer Aufrechterhaltung von ausreichend körperlicher Aktivität über 6 Jahre einhergingen. Dagegen gab es keine Unterschiede zwischen Männern und Frauen, was die Verläufe der Aktivität anging. In Studien mit Menschen ohne Migrationshintergrund werden als häufigste Prädiktoren für positive Verläufe (gleichbleibende oder gesteigerte Aktivität) das männliche Geschlecht, ein niedriger BMI, Nichtraucherstatus, ein hoher Bildungsstand und sozioökonomischer Status, aber auch die körperliche Aktivität und Muskelkraft in der Vergangenheit genannt [120–124].

Studien, die Menschen mit und ohne Migrationshintergrund verglichen, zeigten, dass eingewanderte Personen teils mehr, teils weniger aktiv waren als die Population des Einwanderungslandes, was von der Nationalität der Migranten, aber auch den Gewohnheiten der Population des Einwanderungslandes abhing [125,126].
In Studien, die ausschließlich Migrantenkohorten untersuchten, wurden dagegen ähnliche Prädiktoren für ausreichend körperliche Aktivität wie in der hier vorliegenden Studie identifiziert, insbesondere gute Sprachkenntnisse sowie die Annahme der Nationalität des Einwanderungslandes, da diese das Verständnis für positives Gesundheitsverhalten, die Informiertheit über Sportangebote sowie die soziale Integration erhöhen können [127]. Akkulturation als Konstrukt der Integration in das Einwanderungsland wurde in einigen Studien untersucht, die Ergebnisse sind jedoch heterogen, wobei der Akkulturationsstatus teils mit körperlicher Aktivität assoziiert ist [127–129], teils nicht oder nur in bestimmten Subgruppen [130,131]. Dabei muss allerdings darauf hingewiesen werden, dass Akkulturation unterschiedlich definiert wird und bei den Studien, die eine positive Assoziation zeigten, zwei von drei lediglich die Sprachkenntnisse und die Aufenthaltsdauer mit einbezogen, was wiederum den vorherigen Absatz bestätigt.

Mögliche Maßnahmen zur Erhöhung von körperlicher Aktivität in dieser Population sind zum einen Sprachkurse und generelle Maßnahmen zur Integration in das Einwanderungsland, zum anderen gezielte Präventions- und Aktivitätsangebote, wie z.B. Sportprogramme [132], Hilfe beim Selbstmanagement von Gesundheitsverhalten [133] oder auch motivierende internet- oder

mobiltelefonbasierte Programme, die auf Menschen mit Migrationshintergrund zugeschnitten sind [134].

Körperliche Aktivität während der Coronapandemie

Weiterhin zeigte die vorliegende Arbeit, dass aufgrund von Kontaktbeschränkungen, Anordnung von Home-Office und Schließung von öffentlichen Plätzen und Sportstätten die körperliche Aktivität bei der Population türkeistämmiger Berlinerinnen und Berliner seit Beginn der Coronapandemie im Februar 2020 deutlich zurückging (bei 69% der Befragten) sowie gleichzeitig die Zeit, die mit sitzenden Aktivitäten verbracht wurde, anstieg (bei 36% der Befragten). Ähnliche Veränderungen von körperlicher Aktivität und sitzendem Verhalten konnten in ganz Deutschland und weltweit beobachtet werden, wobei diese Veränderungen z.T. von den von Land zu Land sehr unterschiedlichen Einschränkungen abhingen [135–137].

Prädiktoren für weniger körperliche Aktivität waren in der vorliegenden Studie das weibliche Geschlecht sowie unzureichende Aktivität bereits vor der Pandemie. Dieselben Prädiktoren waren mit mehr sitzendem Verhalten assoziiert, dazu kam hier noch ein zu hoher BMI.
Bezüglich des Geschlechts zeigten Studien unterschiedliche Ergebnisse [138,139], jedoch war - mit einzelnen Ausnahmen - in den meisten Studien die Aktivität vor der Pandemie ein klarer Prädiktor für das Verhalten während der Pandemie, wie auch in der vorliegenden Arbeit gezeigt werden konnte [140–142]. Die Assoziation mit einem zu hohen BMI wurde in beide Richtungen, sowohl als Prädiktor als auch als Folge von zu wenig Aktivität beschrieben [143–145].

Es zeigte sich weiterhin, dass keine migrationsspezifischen Variablen wie Fragebogensprache und Migrationsgeneration mit diesen Veränderungen assoziiert waren, sondern vergleichbare Prädiktoren für die negativen Veränderungen des Aktivitäts- und Sitzverhaltens verantwortlich waren wie in Studien, die nicht speziell ethnische Minderheiten untersucht hatten. Die Datenlage zu Änderungen des Gesundheitsverhaltens bei Personen mit Migrationshintergrund ist – auch international - sehr dürftig. Nur zwei Studien berichteten Ergebnisse zu körperlicher Aktivität während der Coronapandemie. Eine Studie aus den U.S.A. konnte keine Unterschiede zwischen Personen unterschiedlicher ethnischer Hintergründe zeigen [146], während eine britische Studie zeigte, dass ethnische Minderheiten zwar vor der Pandemie genauso aktiv waren wie die Allgemeinbevölkerung, jedoch während der Pandemie eine stärkere Reduktion zeigten [147].

Die Versäumnisse im Bereich der Förderung von körperlicher Aktivität, die bereits seit Jahren bekannt und verantwortlich für die mangelhafte Umsetzung der WHO-Empfehlungen sind, sind während der Coronapandemie überdeutlich geworden. Es ist daher umso wichtiger, schnellstmöglich politische Entscheidungen zur Förderung von körperlicher Aktivität zu treffen und diese voranzutreiben.

3.2. Präventive altersspezifische Interventionsmaßnahmen am Beispiel von körperlicher Aktivität und Tabakkonsum

3.2.1. Interventionen zur Förderung von körperlicher Aktivität bei älteren Menschen

Die vorliegende Arbeit beschreibt die Effekte eines angeleiteten Krafttrainings, das über 8 Wochen zweimal pro Woche mit hochaltrigen Pflegeheimbewohnern durchgeführt wurde, die in ihrer Mobilität eingeschränkt waren. Dieses Krafttraining wirkte sich positiv auf Mobilität und Kraftzuwachs aus.
Ohne Gegenmaßnahmen verringert sich die Muskelkraft mit steigendem Alter, was zum einen mit einer Verringerung von Anzahl und Durchmesser der Muskelfasern, zum anderen mit deren Umbau in Fett- und Bindegewebe erklärt wird [148–150]. Die Muskelfaseranzahl nimmt pro Lebensdekade um etwa 8% ab, die Muskelfaserdichte um etwa 11% bei Männern und 17% bei Frauen) [151]. Von den oben beschriebenen Veränderungen sind generell eher die schnellen (fast-twitch, Typ II) als die langsamen Muskelfasern (slow-twitch, Typ I) betroffen [148,152].

Der Verlust von Muskelkraft kann negative Konsequenzen nach sich ziehen, beispielsweise kann die Selbständigkeit im Alltag nicht mehr aufrecht erhalten werden (Treppen steigen, Einkaufswege zurücklegen, Haushaltsarbeiten, Kontakte pflegen), es besteht ein erhöhtes Risiko zu stürzen (ggf. mit der Folge von Knochenbrüchen oder anderen Verletzungen) oder pflegebedürftig zu werden [153].
Regelmäßige körperliche Aktivität, insbesondere Krafttraining, kann den Prozess des Muskelabbaus aufhalten und sogar reversibel machen. Bereits in den 1990er Jahren führten Fiatarone et al. Studien mit hochaltrigen Personen durch, die zeigten, wie Muskelmasse und -kraft durch gezieltes Krafttraining zunahm, dadurch die Mobilität verbessert und eine gewisse Eigenständigkeit wieder hergestellt werden konnte [154–156]. Die vorliegende Studie zeigte dies ebenfalls und wird durch zahlreiche weitere Studien bestätigt, die mit Älteren oder Hochaltrigen durchgeführt wurden und die positiven Effekte von Krafttraining in Bezug auf Muskelkraft und -funktion [157–163], Balance [164,165], kardiovaskuläre Gesundheit [166], Reversibilität von Sarkopenie [159], Mobilität [160] und Gehgeschwindigkeit [167] belegen. Eine zusätzliche Gabe von Nahrungsergänzungsmitteln (z.B. Proteinpulver) scheint dabei allerdings keinen zusätzlichen Effekt zu haben [158,168].

Obwohl die Datenlage recht eindeutig ist [169], gibt es in Deutschland vergleichsweise wenig strukturierte Programme für diese Zielgruppe. Im Jahr 2002 begann unter dem Namen „Aktiv bleiben im Pflegeheim“ erstmals eine Zusammenarbeit mit Wissenschaftlern und der AOK, die das Ziel hatte, Maßnahmen zur Sturzprophylaxe in den Pflegeheimalltag zu integrieren. Die Implementierung erfolgte in Bayern und Baden-Württemberg sehr erfolgreich und wurde - auch weil vom BMBF Mittel bereitgestellt - umfassend und positiv evaluiert [170–173]. Die

Implementierung in weiteren Bundesländern dagegen wurde von den dortigen AOKs weniger flächendeckend und strukturiert durchgeführt [153].

Im Jahr 2006 wurde darüber hinaus vom Deutschen Netzwerk für Qualitätsentwicklung in der Pflege der „Expertenstandard Sturzprophylaxe in der Pflege“ herausgegeben und 2013 aktualisiert [174], anhand dessen Pflegeheime ihren Bewohnern (Bewegungs-)Programme zur Verfügung stellen können. Die Bundesinitiative Sturzprävention hat 2009 ein Empfehlungspapier für körperliches Training bei älteren zu Hause lebenden Menschen erstellt und bietet im Rahmen des Curriculums „Sturzprophylaxe“ Multiplikatorenschulungen und Zertifizierungen an [175,176]. 2021 wurden die Empfehlungen überarbeitet, richten sich jedoch weiterhin nur an Personen, die zu Hause leben [177]. Die Umsetzung soll auf Landes- oder kommunaler Ebene über Ärzte, Apotheker, Physiotherapeuten, aber auch Landessportbünde etc. gewährleistet werden. Eine Evaluation über den Bekanntheitsgrad bestehender Interventionen existiert nicht, eine Bewertung, inwieweit die Personen, die zur Zielgruppe gehören, über die Angebote informiert sind, ist jedoch dringend erforderlich, um die Maßnahmen und vor allem ihre Verbreitung zu optimieren.

Obwohl ausreichend Evidenz zum Nutzen von Krafttraining bei Pflegeheimbewohnern durch mehrere systematische Übersichtsarbeiten vorliegt, werden in Deutschland weiterhin Studien zum selben Thema durchgeführt. Eine etwas neuere Pilotstudie aus dem Jahr 2017, in der ein intensives Krafttrainingsprogramm in zwei Pflegeheimen getestet wurde, zeigte eine gute Umsetzbarkeit. Bei den durchschnittlich 85-Jährigen konnten Muskelkraft, Balance und habituelle Gehgeschwindigkeit verbessert werden [178]. Eine andere Pilotstudie untersuchte einen Multikomponentenansatz und berichtet positive Ergebnisse in Bezug auf die körperliche Funktion und Wohlbefinden [179]. Eine dritte Pilotstudie testet maschinengestütztes gegen Freihanteltraining und konnte in beiden Gruppen eine Verbesserung der Kraft und Gehgeschwindigkeit feststellen [180].

Eine Weiterführung der Forschung zum Thema Krafttraining/Sturzprävention ist sicher wünschenswert, dennoch sollte statt lokaler Programme, die mit kleinen Studienpopulationen oft nicht belastbare und insgesamt heterogene Ergebnisse liefern, die oberste Priorität die Umsetzung der existierenden Evidenz in konkrete Maßnahmen sein. Untermauert wird diese Forderung durch die Tatsache, dass kurzfristig - z.B. im Rahmen einer Studie - umgesetzte Maßnahmen keine Langzeitwirkung haben, wenn sie nicht fortgeführt werden [181].

3.2.2. Schulbasierte Interventionen zur Tabakprävention

Die vorliegende Arbeit fand keinen Effekt bei den evaluierten Schüler- und Schüler-Eltern-Interventionen zur Tabakprävention, die mit einer Kontrollgruppe und untereinander verglichen wurden. Die resultierenden Kennzahlen zur Risikoreduktion zeigen zwar einen positiven

Trend, jedoch war – möglicherweise aufgrund einer zu geringen Fallzahl und der Clusterung in Schulen und Klassen – keins der Ergebnisse statistisch signifikant. Daneben könnte auch die Intervention an sich (einmaliger Besuch eines Mitmachparcours zur Rauchprävention) nicht ausreichend intensiv gewesen sein.

Die Studienlage zu schulbasierten Interventionen zur Tabakprävention ist sehr heterogen. Ein Cochrane Review aus dem Jahr 2018 beschreibt schulbasierte Tabakprävention als kurzfristig effektiv, Langzeitstudien mit schulbasierten sowie individuelle und familienbasierte Programme dagegen zeigten keine Effekte [182]. Damit wurde ein früheres Cochrane Review bestätigt, das ebenfalls keine Langzeiteffekte von anreizbasierten Präventionsprogrammen bei Schülern zeigte [183]. Einen positiven Effekt zeigten Präventionsprogramme, die mit Peers, also z.B. Mitschülern oder auch (Medizin-)studierenden arbeiteten [184,185], Programme, die neben Wissensvermittlung anschauliche Experimente durchführten und die persönlichen Bedürfnisse der Schüler förderten [185–187]) sowie massenmediale Kampagnen, die mit häufigem Schülerkontakt und über mindestens 3 Jahre durchgeführt wurden [188]. Jedoch gab es auch multimodale Programme, die trotz ähnlich konzipierter Interventionen keine Effekte zeigten [189,190]. Rein wissensbasierte Programme zeigten generell keinen Effekt auf das Rauchverhalten der Schüler [191–194]. Auch komplexe Präventionsprogramme, die mehrere Gesundheitsverhaltensweisen (neben Rauchen meist Drogenmissbrauch, Alkoholkonsum, seltener auch Ernährung und Bewegung) adressierten, deuteten auf keinen Effekt dieser Intervention auf das Rauchen hin [195–197].

Auch die in Deutschland etablierten Programme werden versucht wissenschaftlich zu begleiten. Das Programm „be smart don't start" für Jugendliche wurde 1997 als extrakurrikulare Maßnahme für 6. bis 8. Klassen in Schulen eingeführt und findet großen Anklang bei Schülern, was mit der Verlosung von Klassenfahrten für erfolgreich abstinente Schulklassen zu tun haben dürfte; erreicht wurden 2003 allerdings nur zwischen 1 bis 12% der Zielpopulation [198]. Die Reichweite hat sich auch in den folgenden 15 Jahre kaum weiterentwickelt und betrug im Jahr 2018 durchschnittlich ca. 10% aller Schulklassen. Darüber hinaus gibt es Klassen, die mehrfach teilnehmen, eine genaue Bestimmung der Verbreitung ist daher nicht möglich [96].
Bezüglich der Effektivität gibt es zwar Hinweise auf höhere Nichtraucherquoten unter den teilnehmenden Schülern, es fehlt jedoch eine klare Evidenz [96,199,200]. Dies liegt zum einen daran, dass sehr wenige randomisierte kontrollierte Studien durchgeführt wurden [201] und zum anderen, dass die Angaben zur Abstinenz der Schüler nur auf Vertrauensbasis erhoben und nicht nachgewiesen werden können [202,203]; darüber hinaus weisen die meisten Studien hohe Attritionsraten auf, so dass selbst positive Ergebnisse mit Vorsicht zu betrachten sind [203,204].

3.3. Ausblick

Deutschland hat eine solide Forschungsbasis zum Thema körperliche Aktivität und Tabakkonsum. Epidemiologische Daten stehen zur Verfügung, vulnerable Gruppen sind bekannt. Dennoch mangelt es an praktischen Konzepten zur Umsetzung zielgruppen- und settingorientierter Präventionsmaßnahmen.

Mit den „Nationalen Empfehlungen für Bewegung und Bewegungsförderung“ von 2016 gibt es in Deutschland nun zwar ein Dokument, das sich an Akteure aus dem Bereich der Sportförderung richtet, einfach verständliche Informationen für die Bevölkerung fehlen jedoch weiterhin. Es ist daher nicht überraschend, dass die in dem Dokument zusammengefassten Empfehlungen von 80% der Deutschen nicht eingehalten werden [205].

Entsprechend der bestehenden Guidelines zur Verbreitung von Informationen zu körperlicher Aktivität sollte die Bevölkerung durch Information und Zugang zu entsprechenden Maßnahmen unterstützt werden. Dabei sollte der Kontext und die Zielgruppe berücksichtigt werden sowie geeignete Personen für die Kommunikation der Informationen bestimmt werden [206].

Wie im Global Action Plan der WHO beschrieben, sollte die Förderung von körperlicher Aktivität 4 übergeordneten Zielen folgen.

1. Erschaffung aktiver **Systeme**:
   Aufbau und Stärkung von Governance und sektorübergreifenden Partnerschaften, koordinierte Zusammenarbeit internationaler, nationaler und subnationaler Maßnahmen zur Steigerung der körperlichen Aktivität
2. Erschaffung aktiver **Gesellschaften:**
   Paradigmenwechsel in der gesamten Gesellschaft durch Verbesserung von Wissen und Verständnis für die vielfältigen Vorteile regelmäßiger körperlicher Betätigung
3. Erschaffung einer aktiven **Umwelt:**
   Schaffung und Erhaltung eines Umfelds mit gleichberechtigtem Zugang zu sicheren Orten und Räumen in Städten und Gemeinden, in denen sich die Menschen je nach ihren Fähigkeiten regelmäßig körperlich betätigen können
4. Erschaffung aktiver **Menschen**:
   Schaffung von Möglichkeiten und Programmen in verschiedenen Bereichen, um Menschen aller Altersgruppen und Fähigkeiten zu helfen, sich als Einzelpersonen, Familien und Gemeinschaften regelmäßig körperlich zu betätigen.

Im Rahmen des Sports, Medicine and Health Summit 2021 in Hamburg haben 50 Organisationen die sogenannte „Hamburg Declaration 2021 – Global Alliance for the Promotion of Physical Activity“ und damit ihren Beitrag zu einer globalen Förderung körperlicher Aktivität unterzeichnet. Der Auftrag lautet: „Alle relevanten Organisationen innerhalb der Allianz werden alle Aktionen, Projekte, Forschungen, Publikationen,

Marketingstrategien, in einem einheitlichen Ansatz mit einem gemeinsamen Ziel, aber entsprechend ihrer speziellen Ziele und Aufgaben in unterschiedliche Rollen spielen.“ [207]. Die Stadt Hamburg geht mit dem Projekt „Hamburg Active City“ als gutes Bespiel voran [208] und auch viele deutsche Organisationen beteiligen sich an dieser Allianz. Dennoch ist es unumgänglich, dass auf nationaler politischer Ebene die Aufklärung und Förderung von körperlicher Aktivität weiter vorangetrieben und die Bevölkerung mit einbezogen wird.

Auch beim Nichtraucherschutz liegt mit dem Strategiepapier des DKFZ ein Dokument vor, das theoretisch alle nötigen für die Zielerreichung umzusetzenden Maßnahmen beschreibt, die durch die WHO (MPOWER) und die Tabakkontrollskala schon seit vielen Jahren gefordert werden (Abbildung 8).

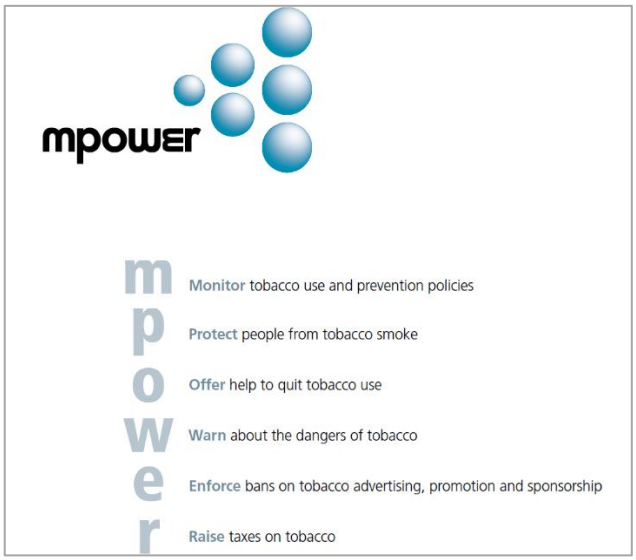

Abbildung 8. *Das MPOWER Schema der WHO fasst die Strategien zur Umsetzung einer nachhaltigen Tabakprävention zusammen.* Quelle: WHO Report on the global tobacco epidemic, 2021 [209].

Dass ein guter Plan allein nicht ausreicht, hat die Unterzeichnung des FCTC im Jahr 2010 und die nachfolgende Untätigkeit Deutschlands bei der Tabakkontrolle gezeigt. Es ist daher nötig, die Politik mehr in die Verantwortung zu nehmen, um Maßnahmen wie z.B. Nichtraucherschutz, Warnhinweise auf Zigarettenschachteln, Tabaksteuererhöhung oder Werbeverbote schnellstmöglich umzusetzen. Auch die Markteinführung immer neuer Produkte wie E-Zigaretten oder Tabakerhitzer durch die Zigarettenindustrie, die scheinbar gesünder sind als Zigaretten, gilt es zu monitorieren und regulieren.

4. Zusammenfassung

In Deutschland werden die Empfehlungen bezüglich körperlicher Aktivität nur unzureichend erfüllt. Gründe dafür sind multifaktoriell. Für Jugendliche und Personen mit türkeistämmigem Migrationshintergrund konnten mittels bevölkerungsbasierter Studien mehrere Determinanten für Inaktivität identifiziert werden. Diese Faktoren sollten bei der Entwicklung von zielgruppenspezifischen Präventionsmaßnahmen in Deutschland besser berücksichtigt werden. Insbesondere Mädchen sollten verstärkt zu körperlicher Aktivität motiviert werden, während bei Jungen und sozial schwächeren Jugendlichen das Angebot von Alternativen zur Bildschirmzeit im Fokus stehen sollten. Personen mit Migrationshintergrund, die schlechte Deutschkenntnisse haben, sollten mehrsprachige Bewegungsförderungsprogramme angeboten werden.

Eine weitere - besonders vulnerable - Bevölkerungsgruppe sind hochbetagte Menschen. Krafttraining zweimal pro Woche kann helfen, die Muskelkraft und -funktion aufrecht zu erhalten. Dadurch kann die Mobilität verbessert oder zurückgewonnen werden. Da es für jedes Individuum das wichtigste Gut ist, die eigene Selbständigkeit so lange wie möglich aufrecht zu erhalten, sollten Krafttrainingsprogramme flächendeckend in Pflegeheimen etabliert werden.

Vulnerabel ist eine Population auch dann, wenn sie in eine Krisensituation gerät. Die seit Anfang 2020 herrschende Coronapandemie hat gezeigt, wie schnell Einschränkungen des normalen Alltags zu Bewegungsmangel und zu viel Sitzen führen. Zwar konnten auch in der Ausnahmesituation eines Lockdowns bestimmte Gruppen ihre Aktivität besser aufrechterhalten als andere, dennoch zeigte die Krise, dass ein nationales Konzept zur Bewegungsförderung in Deutschland fehlt. Es braucht eine bundesweite Kampagne zur Information zu und Förderung von körperlicher Aktivität, die langfristig angelegt, regelmäßig evaluiert und bevölkerungsweit kommuniziert und umgesetzt werden muss.

Obwohl der Tabakkonsum bei Jugendlichen in den letzten 20 Jahren deutlich zurückgegangen ist, ist die Raucherprävalenz in Deutschland weiterhin höher als in den meisten anderen europäischen Ländern. In der vorliegenden Schrift wurde dargelegt, dass nur wenige schulbasierte Einzelmaßnahmen im Rahmen der Verhaltensprävention den erhofften Effekt haben. Verhältnispräventive Maßnahmen sind dagegen beim Nichtraucherschutz deutlich effektiver. Die im Rahmen des Framework Convention on Tobacco Control vereinbarten Maßnahmen wurden von Deutschland jedoch immer noch nicht in befriedigender Weise eingeführt. Um die für 2040 gesetzten Ziele (Raucherprävalenz von 2% bei Jugendlichen und 5% bei Erwachsenen) zu erreichen, ist es dringend nötig, dass in Deutschland die in der europäischen Tabakkontrollskala und im MPOWER Katalog der WHO geforderten Maßnahmen umgesetzt werden.

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Erklärung

§ 4 Abs. 3 (k) der HabOMed der Charité

Hiermit erkläre ich, dass

- weder früher noch gleichzeitig ein Habilitationsverfahren durchgeführt oder angemeldet wurde,
- die vorgelegte Habilitationsschrift ohne fremde Hilfe verfasst, die beschriebenen Ergebnisse selbst gewonnen sowie die verwendeten Hilfsmittel, die Zusammenarbeit mit anderen Wissenschaftlern/ Wissenschaftlerinnen und mit technischen Hilfskräften sowie die verwendete Literatur vollständig in der Habilitationsschrift angegeben wurden.
- mir die geltende Habilitationsordnung bekannt ist.

Ich erkläre ferner, dass mir die Satzung der Charité – Universitätsmedizin Berlin zur Sicherung Guter Wissenschaftlicher Praxis bekannt ist und ich mich zur Einhaltung dieser Satzung verpflichte.

15.2.2022 ……..

Datum Unterschrift