Landeszentrum Gesundheit
Nordrhein-Westfalen

Physical activity in DYNAMO-HIA.

Report on data collection for physical activity prevalence in NRW and related relative risks for different health outcomes for dynamic HIA modelling.

GESUNDHEITSCAMPUS
NORDRHEIN-WESTFALEN

www.lzg.nrw.de

Physical activity in DYNAMO-HIA.

Report on data collection for physical activity prevalence in NRW and related relative risks for different health outcomes for dynamic HIA modelling.

A methodology report.

Landeszentrum Gesundheit Nordrhein-Westfalen

Impressum
Landeszentrum Gesundheit
Nordrhein-Westfalen (LZG.NRW)
Gesundheitscampus 10
44801 Bochum
Telefon 0234 91535-0
Telefax 0234 91535-1694
poststelle@lzg.nrw.de
www.lzg.nrw.de

Autorinnen
Monika Mensing, Odile CL Mekel, LZG.NRW

unter Mitwirkung von
Sarah Beckmann
Maren Berendonck
Andrea Gerber

Redaktionelle Bearbeitung
LZG.NRW, Bochum

Layout und Verlag
LZG.NRW

Bildnachweis
Titelmotiv: © ComicVector – stock.adobe.com

Das LZG.NRW ist eine Einrichtung des Landes Nordrhein-Westfalen und gehört zum Geschäftsbereich des Ministeriums für Arbeit, Gesundheit und Soziales.

Bochum, Dezember 2018

ISBN 978-3-88139-210-5

Table of contents

List of figures

all figures developed by LZG.NRW

List of tables

all tables developed by LZG.NRW

Acknowledgements

We used original data from the Robert Koch-Institute (RKI) which we would like to acknowledge:

1. German Interview and Examination Survey for Children and Adolescents (KiGGS) Wave 1 from 2009 to 2012 for age 3-17 years [1]
2. German Health Update (GEDA) [2] from 2009, 2010 and 2012 for age 18+ years.

These data were re-analysed to obtain the information required by the DYNAMO-HIA model.

Zusammenfassung

Körperliche Inaktivität ist als Risikofaktor für eine Vielzahl negativer gesundheitlicher Folgen epidemiologisch etabliert, insb. für koronare Herzerkrankungen, Schlaganfall, Diabetes mellitus Typ 2 sowie einige Krebserkrankungen. In Nordrhein-Westfalen (NRW) werden vielfältige Anstrengungen unternommen, um körperliche Aktivität und Bewegung zu steigern und somit die Gesundheit der Bevölkerung zu fördern.

Der vorliegende Bericht fasst die vom LZG.NRW verwendeten Ansätze, Datenquellen und Verfahren zusammen, um alters- und geschlechtsspezifische Daten über das Vorliegen und das Ausmaß körperlicher Aktivität der Bevölkerung in NRW, sowie alters- und geschlechtsspezifische relative Risiken für assoziierte Erkrankungen zu erhalten. Diese Daten sind erforderlich, um das zukünftige Ausmaß unzureichender körperlicher Bewegung und die dadurch beeinflusste Krankheitslast in NRW dynamisch zu modellieren, wobei potenzielle Gesundheitsgewinne durch erfolgreiche Bewegungsinterventionen berücksichtigt werden. Diese modellierten quantitativen Effektschätzer können eine wichtige Unterstützung der Entscheidungsträger auf gesundheitspolitischer Ebene darstellen, in Hinblick auf gesundheitsförderliche Maßnahmen, Projekte und Strategien, die die Gesundheitsgewinne für die Bevölkerung oder für spezielle Zielgruppen steigern können.

Für die Modellierung steht das Markov-basierte DYNAMO-HIA Instrument (‘DYNAmic MOdel for Health Impact Assessment’) zur Verfügung. Es ermöglicht eine quantitative Abschätzung langfristiger gesundheitlicher Auswirkungen politischer Entscheidungen und Interventionen auf Bevölkerungsebene. Dabei erfolgt die Simulation auf Grundlage epidemiologischer kausaler Wirkungsketten, wobei auch individuelle Veränderungen der Risiko-Exposition im Laufe des Lebens berücksichtigt werden.

Für die Erfassung der aktuellen Bewegungsprävalenz in NRW wurden kategoriale Daten genutzt, die sich an den Bewegungsempfehlungen der Weltgesundheitsorganisation (WHO) orientieren. Danach sollen sich 5-17-Jährige mindestens 60 Minuten täglich mit mindestens moderater Intensität bewegen; Erwachsene mindestens 30 Minuten an mindestens 5 Tagen/Woche. Als weitere Prüfkriterien wurden die Erfassung möglichst aller Formen körperlicher Aktivität, hohe Studienqualität und -größe, Repräsentativität und Aktualität der Studie angewendet. Für Kinder und Jugendliche konnten keine ausreichend guten Daten auf NRW-Ebene identifiziert werden, daher werden für diese Altersgruppe die Daten der ersten Folgeerhebung der bundesweiten »Studie zur Gesundheit von Kindern und Jugendlichen in Deutschland (KiGGS Welle 1)« verwendet. Diese Studie aus dem Zeitraum 2009 – 2012 hält Daten von über 12.000 Kindern und Jugendlichen im Alter von 0-17 Jahren vor. Für die Gruppe der Erwachsenen wird ein NRW-Datensatz (n > 13.000) verwendet, der sich aus drei Wellen der Studie »Gesundheit in Deutschland aktuell (GEDA)« aus den Jahren 2009, 2010 und 2012 zusammensetzt. Im finalen Datensatz wurde das Ausmaß der erhobenen körperlichen Aktivität in 3 Gruppen kategorisiert (gering, mittel, hoch) und die Daten abschließend geglättet.

Die mit Bewegungsmangel evident assoziierten Gesundheitsfolgen sind kardiovaskuläre Erkrankungen, vorzeitige Sterblichkeit, Darmkrebs, Brustkrebs sowie Diabetes mellitus Typ 2. Eine umfangreiche Literaturrecherche wurde durchgeführt, um robuste Schätzer für relative Erkrankungsrisiken durch Bewegungsmangel zu identifizieren. Dabei wurden insbesondere solche Studien und Meta-Analysen präferiert, die die erhobene körperliche Aktivität in vergleichbarer Form sowie in Anlehnung an die WHO-Bewegungsempfehlungen klassifizieren. Nach Anwendung der im Vorfeld definierten Ein- und Ausschlusskriterien konnten relative Risikoschätzer für alle relevanten Gesundheitsfolgen für die Nutzung in DYNAMO-HIA identifiziert werden. Auf Ursachen möglicher Schätzunsicherheiten und -verzerrungen, die auf die Daten selbst oder ihre Aufbereitung zurückzuführen sind, wird im Bericht ebenfalls hingewiesen.

Die ermittelten Daten sowohl zur Prävalenz körperlicher Aktivität als auch zu den Dosis-Wirkungsbeziehungen (in Form relativer Risiken) mit assoziierten Erkrankungen können nun im nächsten Schritt in das DYNAMO-HIA Tool eingespeist werden und bilden somit die Grundlage für die Modellierung geschätzter Gesundheitseffekte durch Bewegungsinterventionen in NRW.

Abstract

Physical inactivity has long been identified to cause negative effects on different health outcomes, e.g. coronary heart diseases, stroke, diabetes mellitus type 2 and some cancers. In North Rhine-Westphalia (NRW), substantial efforts are made to increase the amount of physical activity (PA) and exercise, in order to promote population health.

This report summarizes the approaches, data sources, references and procedures used by the NRW Centre for Health (LZG.NRW) to obtain age- and gender-specific data on physical activity exposure levels in NRW, as well as age- and gender-specific relative risks for selected health outcomes associated with physical activity. These data are essential for the dynamic modelling of future prevalence rates of insufficient physical activity levels and related diseases, taking potential health gains of intervention measures into account. The resulting modelled estimates may support decision-makers when deciding for action strategies, policies and specific population focus groups, aiming at maximum health gains for (parts of) the population.

The modelling will be performed using the Markov-based DYNAMO-HIA tool ('DYNAmic MOdel for Health Impact Assessment'). It allows the estimation and quantification of long-term impacts on population health, due to policies and interventions. Based on underlying epidemiological causal chains, the model simulates a target population dynamically through time, considering changes in individuals' exposure to a risk factor in the life course.

The implementation of physical activity prevalence was facilitated by using categorized data, following recommendations of the World Health Organization (WHO) from 2004 (children 5-17 years: 60+ minutes of physical activity every day with at least moderate intensity; adults: 30+ minutes of physical activity at least 5 times a week with at least moderate intensity). Further criteria were applied to identify potential physical activity prevalence data for NRW e.g. the consideration of different facets of physical activity, a high degree of quality, timeliness, size and representativeness of the data sets.

For children and adolescents, no NRW-specific data could be identified that met the criteria. Alternatively, national data from the »German Interview and Examination Survey for Children and Adolescents (KiGGS Wave 1)« will be used. This survey was carried out from 2009-2012 with over 12,000 participants aged 0-17 years. For adults, 3 NRW sub-samples of the »German Health Update (GEDA)« from the years 2009, 2010 and 2012 were merged, offering a sample size of over 13,000 individuals for NRW.

A final data sheet of both data sets was composed and smoothed, with physical activity exposure classified in 3 categories (low, intermediate, high).

The health outcomes evidently identified to be associated with physical inactivity are cardiovascular diseases (CVD), premature all-cause mortality, colon and rectal cancer, breast cancer and diabetes mellitus type 2. A comprehensive literature search in different databases was conducted to identify robust relative risk estimates, guiding towards studies and meta-analyses that used a similar way of categorizing physical activity in accordance with WHO recommendations.

We identified reliable and representative data on physical activity prevalence and dose-response relations (RR) with associated diseases. These gender- and age-specific data can now be embedded in the tool and provide the basis for modelling impact estimates of physical activity interventions in NRW. The discussion on potential sources of uncertainty and bias with regard to the data sources and data handling conclude the report.

1. Introduction

Health Impact Assessment (HIA) is a "combination of procedures, methods and tools by which a policy, programme or project may be judged as to its potential effects on the health of a population, and the distribution of those effects within the population" [3]. In Germany, HIAs are performed since the early 1990s, focussing on estimating population-based health impacts due to environmental exposures [4]. Later on in the early 2000s, HIAs have been initiated for the exposure to health-relevant behaviours (e.g. alcohol and smoking), social determinants (e.g. an obligatory kindergarten year [5]) or a state regulation (e.g. taxing sugar sweetened drinks [6]) in a systematic procedure [7].

Quantitative modelling allows impact estimates for alternative options and their direct comparison, providing valuable information to derive recommendations for action. In recent years, different tools and models have been developed to facilitate quantitative HIA, that differ with regard to status quo of development, availability, or coverage of topics [4, 8]. A survey on toolmakers of 17 different tools for quantitative HIA was conducted by Fehr et al [9], including the development team of the DYNAMO-HIA tool.

DYNAMO-HIA is a project leading to the development of the DYNAMO-HIA tool for quantifying the health impact of policies in the European Union (EU). The project was funded by the European Commission and conducted by leading public health institutions, and the tool was used for modelling alternative risk factor scenarios with their health impacts [10]. To date, the generic tool was applied in Europe for the risk factor smoking, BMI and alcohol [11-14] and for salt intake [15, 16]. For Germany, health impacts of second-hand smoke were assessed with the tool for IHD, COPD and stroke [17].

After testing and adjusting the tool for conditions in NRW by modelling risk factors preinstalled in the tool, the NRW Centre for Health aims at examining physical activity prevalence and its health impact on chronical diseases at subnational level (NRW) with the utilization of DYNAMO-HIA. A sedentary lifestyle has long been identified to cause negative effects on different health outcomes, e.g. coronary heart diseases, stroke, breast and colon cancer, overall mortality and T2DM. For example, insufficient physical activity is estimated to acount for 16% of risk factor contribution of T2DM in German 50-69-olds, and for 19% in the age group 70 and older [18]. Modelling of future physical activity prevalence and selected health implications in the NRW population has the potential to supporting Health Impact Assessment of movement-promoting policies in NRW by quantitative effect estimates.

In 2011, the RIVM was commissioned by the predecessor institute of LZG.NRW to perform an in-depth literature research within the framework of a work contract, in order to derive robust relative risk estimates for insufficient physical activity and associated health outcomes, to be used in dynamic modelling for NRW [19]. This research was based on the premise that, in NRW, prevalence data for the risk factor (physical activity) is only available for 'sporting activitities', excluding all other occasions of movement. This data restriction led to limited search results for the interesting outcomes, esp., no reliable studies for the effects of insufficient physical activity in form of sports on the risk for diabetes mellitus typ 2 could be detected. Due to extensive and comprehensive physical activity data sources now available, these former difficulties can be overcome.

The present report provides general information on physical activity data sources, and explains the selection process employed by the NRW Centre for Health to obtain required age- and gender-specific prevalence data on physical activity (Part 1), as well as estimates of age- and gender-specific relative risks (RRs) for selected diseases associated which insufficient physical activity (Part 2).

The objectives of this report are to:

- examine existing physical activity data sources regarding their suitability to be integrated in the DYNAMO-HIA model;
- collect reliable age- and gender-specific physical activity prevalence data preferably for the NRW population;
- determine age- and gender-specific relative risks (RR) for diseases and mortality associated with physical activity, and to evaluate if the categorisation of physical activity exposure in the considered studies corresponds to the categorisation of physical activity of existing prevalence data.

The report illustrates the specific selection criteria for the best possible prevalence data as well as dose-response-relationship data, and introduces the chosen data sources based on these selection criteria.

2. Estimating prevalence of physical activity

Any bodily movement generated in the musculoskeletal system that expends energy is called physical activity. It is indispensable for improving and maintaining physical and mental health and risk-reducing to many non-communicable diseases. But, as a global response to diminishing movement necessities these days, every fourth adult is not health-sufficiently physically active. The growing lack of physical activity presents the fourth leading risk factor for global mortality, currently causing an estimated annual average of 3.2 million deaths globally [20].

Intensive population interventions and policy actions could and should help to increase physical activity [21]. The DYNAMO-HIA tool enables a dynamic Markov-based modelling of those health impacts that can be adjusted to current situations. By simulating alternative prevention and intervention scenarios, the impact of measures can be estimated quantitatively. These estimates may support decision-makers when deciding for action strategies, policies and specific population focus groups, aiming at maximum health gains for (parts of) the population.

The key prerequisite for modelling the effects of physical activity interventions and policies is the definition of the exposure variable "physical inactivity", in other words: the risk factor.

It is necessary to enter information about today's prevalence of the risk factor to the model: how are different levels of inactivity distributed in the population, how many people are 'exposed' to physical activity levels that are low or too low?

This question must be considered thoroughly. Physical activity can be undertaken in many different ways, e.g. walking, cycling, sports and recreation, outside, at work, as well as around the home, vigorously or moderate, for leisure, commuting, transportation etc. The main dimensions in this context are inducement and type of activity, its frequency, regularity, duration and intensity in particular. This diversity of physical activity dimensions is being reflected in inconsistent classifications and measurements in surveys and studies that are collecting data on the amount

– the prevalence – of physical activity. Hence, before the modelling of alternative scenarios can take place, the operationalisation of the risk factor "physical inactivity" has to be narrowed to manageable categories.

Taking a closer look at official physical activity recommendations for different age groups (see chapter 2.1.) represents an important first step in this context. Depending on age, these recommendations define the minimal requirements of physical activity to be performed, in order to gain established and beneficial health effects, like improvement of cardiorespiratory and muscular fitness, bone health, mental health and risk reduction for non-communicable diseases. Hence, these recommendations provide the framework for the classification of the exposure variable physical (in)activity.

2.1. Selection of exposure variables

Preliminary remarks

In the scientific sense, physical activity intensity is classified by using the "Metabolic Equivalent of Task" (MET), which allows the comparison of the energy expenditure during different activities. It is defined as the ratio of work metabolic rate to a standard resting metabolic rate in relation to the body weight. The metabolic rate describes the rate of energy expenditure per unit time. 1 MET means a resting metabolic rate resulting during e.g. quiet sitting. In doing so, men consume approx. 3.5 ml oxygen per kilogram body weight per minute, women approx. 3.15 ml [22]. Based on MET, physical activity intensity can be categorised as follows [23]:

Table 1. Categorisation of physical activity intensity in Metabolic Equivalent of Task (MET)

Category	MET (ml/kg/min)
Light	**<3 MET** e.g. sleeping, sitting, slow walking
moderate	**3-6 MET** e.g. bicycling or walking with small to moderate effort
vigorous	**>6 MET** e.g. running, jumping, activities with vigorous effort

Noteworthy: MET facilitates the classification and comparison of the various forms of physical movement. Measuring physical activity intensity using METs requires mobile sensor measuring systems, and surveys are still in their beginning to use those systems. For large representative surveys though, the procedure cannot (yet) be used efficiently. Alternatively, surveys can query in detail about all physical activity that takes place through the day, aiming at MET estimates on individual level. For NRW and Germany, this data ist not yet available on a representative level.

Adjustments in official physical activity recommendations over time

In order to implement the amount (= the prevalence) of physical activity in epidemiologic models, and to simulate the health effects of modified amounts, categorisation of physical activity is necessary. A useful preliminary step to assign physical activity prevalence in sensible categories, is the examination of official recommendations. Scientific knowledge growth about the necessary amounts and components of physical activity (in order to be beneficial for health) has led to corresponding adoptions and adjustments of recommendations over time by different leading health organisations worldwide. Most of today's recommendations on physical activity are based on an U.S. recommendation from 1995: "Every US adult should accumulate 30 minutes or more of moderate intensity physical activity on most, preferably all, days of the week" [23]. Comprehensive reviews of large cohort studies lead to evidence-based revisions of recommendations over time: In 2004, the World Health Organization (WHO) defined in more detail, that physical activity units should be performed on at least 5 days a week [24]. The most recent and more detailed WHO recommendations on physical activity [25] involve a higher degree of complexity, taking into account that health promoting effects can best be gained by combining aerobic and unaerobic exercises with those that strengthen the muscles and bones. The additional health effects of physical activity above the recommended minimum amount are also mentioned explicitly. Detailed information on these recommendations are shown below:

Age 5-17

For children and young people, physical activity includes play, games, sports, transportation, recreation, physical education or planned exercise, in the context of family, school and community activities. In order to improve cardiorespiratory and muscular fitness, bone health, cardiovascular and metabolic health markers und reduce symptoms of anxiety and depression:

- Children and youth aged 5-17 should accumulate at least 60 minutes of moderate- to vigorous- intensity physical activity daily.
- Amounts of physical activity greater than 60 minutes provide additional health benefits.
- Most of the daily physical activity should be aerobic. Vigorous-intensity activities should be incorporated, including those that strengthen muscle and bone, at least 3 times per week.

Age 18 - 64

Physical activity in adults aged 18-64 includes leisure time physical activity, transportation (e.g. walking or cycling), occupational (i.e. work), household chores, play, games, sports or planned exercise, in the context of daily, family and community activities. In order to improve cardiorespiratory and muscular fitness, bone health, reduce the risk of non-communicable diseases and depression:

- Adults aged 18-64 should do at least 150 minutes of moderate-intensity aerobic physical activity throughout the week, or do at least 75 minutes of vigorous-intensity aerobic physical activity throughout the week, or an equivalent combination of moderate- and vigorous-intensity activity.
- Aerobic activity should be performed in bouts of at least 10 minutes duration.
- For additional health benefits, adults should increase their moderate-intensity aerobic physical activity to 300 minutes per week, or engage in 150 minutes of vigorous-intensity aerobic physical activity per week, or an equivalent combination of moderate- and vigorous-intensity activity.
- Muscle-strengthening activities should be done involving major muscle groups on 2 or more days a week.

Age 65 +

In older adults of the 65 years and above group, physical activity includes leisure time physical activity, transportation (e.g. walking or cycling), occupational (if the individual is still engaged in work), household chores, play, games, sports or planned exercise, in the context of daily, family and community activities. In order to improve cardiorespiratory and muscular fitness, bone and functional health, reduce the risk of NCDs, depression and cognitive decline, the same recommendations as for adults at age 18-64 apply, in addition:

- Adults of this age-group, with poor mobility, should perform physical activity to enhance balance and prevent falls on 3 or more days per week.
- When adults of this age group cannot do the recommended amounts of physical activity due to health conditions, they should be as physically active as their abilities and conditions allow.

People with limited health status or mobility

(e. g. cardiac events, but also pregnancy) may have to take precautions and seek medical advice before trying to meet the recommendations on physical activity [25].

For children and infants under 5 years

the UK Health Departments recommend enhancing their physical activity continuously to decrease a movement deficit. The recommendation for infants who are already able to walk consists of 180 minutes (3 hours) physical activity per day, in which every movement counts [26]. The recommendations elaborated in Germany target a continuous encouragement of physical activity for infants and young children as well. Furthermore, they emphasise the strengthening of complex movements to promote the motoric development [27].

Modelling the health outcomes in alternative scenarios (with varying levels of exposure to a risk factor, here: physical inactivity) requires the explicit definition of the risk factor and its exposure degrees, but also reliable and evident relative risks that link these exposure degrees to disease probabilities. A categorical physical activity exposure variable meets these requirements rather than a discrete variable when using survey data:

- participants, in most cases, submit only approximate information about their amount of physical activity per day or week;
- consequently, there is a larger availability of meta-analyses and large-scale studies using physical activity classifications to report dose-response relationships between physical activity and associated diseases;
- the specification of categories can be done in accordance to the recent official physical activity recommendations as presented above (minutes per day/week).

Classifying the amounts of minutes of weekly physical activity into 2 groups (insufficient/sufficient) or 3 groups (low/intermediate/high) therefore facilitates to generate the physical activity estimates required for the modelling process as realistic as possible.

Yet, the issue remains that there are aspects comprised in the recommendations [24, 25], that raise the problem of missing data: to date, there are no representative surveys that collect data differentiating between 'endurance activities' and 'muscle strengthening activities'. Following the approach of the Robert Koch-Institute at German national level, we chose a solution in compliance with the former recommendations of 2004 (children 5-17 y: 60 min every day with at least moderate intensity; adults: 30 min at least 5 times a week with at least moderate intensity). This approach results in a natural 2-category solution of classification: the recommendation for the particular age group is either fulfilled or not (table 2, left column).

Table 2. Operational classification of physical activity (PA) considering intensity, duration and regularity

	2 categories	
	category	**PA (min/time unit)**
Age 5 – 17 years	meeting recommendations sufficient PA	≥60 every day
Age 5 – 17 years	not meeting recommendations insufficient PA	< 60 every day or ≥60 on < 7 days/week
Age 18+ years	meeting recommendations sufficient PA	≥150 (moderate) or ≥75 (vigorous) on ≥5 days/week
Age 18+ years	not meeting recommendations insufficient PA	<150 (moderate) and <75 (vigorous) or on < 5 days/week

3 categories	
category	**PA (min/time unit)**
meeting recommendations high PA	≥60 every day
active, but not meeting recommendations intermediate PA	≥60 on <7 days/week or < 60 every day
little / no physical activity low physical activity	< 60 every day on <7 days/week
meeting recommendations high PA	≥150 (moderate) or ≥75 (vigorous) on ≥5 days/week
active, but not meeting recommendations intermediate PA	≥150 (moderate) or ≥75 (vigorous) on <5 days/week
little / no physical activity low PA	<150 (moderate) and <75 (vigorous)

We also consider a 3-category-solution (table 2, right column), taking "intermediate" levels of physical activity into account, provided that relative risks for associated diseases for 3 levels of physical activity exposure are reported in the literature. The 3-category-solution is preferable, as intervention scenarios can be simulated closer to reality.

In summary, the risk exposure variable should give representative age- and sex-specific information on individual level about the duration of physical activities, as well as their frequency and regularity, if possible, about their intensity, in 3 categories, following the WHO-recommendations of 2004.

2.2. General approach for obtaining data on physical activity and evaluation of suitability

There are different ways and instruments collecting data on PA. Mobile sensor systems, e. g. electromechanical step counters or accelerometers, are used increasingly to measure people's physical activity duration and intensity [28]. These rather expensive methodologies are still in their beginning stages and cannot yet supply representative data due to small sample sizes of the studies. Hence, data on physical activity is usually collected via surveys, questionnaires and interviews. These quantitative data collection methods are more convenient but less precise; the perception of the intensity of movements is individual and influenced by many factors, moreover, overestimation of individual physical activity duration and intensity is common, which may lead to differential misclassification due to an information reporting bias [29, 30]. Especially elderly people can be confused with the categories and subsequently over- or underestimate their PA-behavior [31].

Cost-efficient computer-assisted telephone and personal interviews (CATI resp. CAPI) were used in most of the considered studies for collecting self-reported data on PA. It implies the methodological limitations indicated above, yet offers eligible, comprehensive and representative data sets physical activity to be imported into DYNAMO-HIA.

2.3. Data collection and estimation methods

2.3.1. Criteria used for selecting sources of individual-level data on physical activity

The following criteria were applied to identify potential physical activity prevalence data for NRW:

»Questions on general physical activity« Data on general physical activity, independently from inducement, is preferable over data focussing on selected activity occasions e.g. leisure-time, occupational, transportation/commuting, household or sporting activities, to account for all participants' physical activities as comprehensive and broad as possible. As a minimum prequisite, the data set has to give information about the frequency and duration of physical activity per week.

»Classification following WHO-recommendations« The data on general physical activity should be classified (or should be in a format that allows classification) preferably in compliance with (current) WHO-recommendations, to derive a comparable and informative data classification set (see table 2).

Time frame Most recent data are preferred. Data collected from the year 2009 on were included.

»Sample size and representativeness« Because of the need of robust data on every single year of age, data based on the largest possible sample sizes is preferred. The data needs to be representative for NRW as the focus region. Alternatively, if no data is available on regional NRW level, the data needs to be representative at least on national level for Germany.

»Further data characteristics« The modelling requires sex- and age-specific prevalence data for every age year 0 - 95. Hence, the data has to be available by different age groups, covering a wide age range, as well as by gender. The data has to be accessible on individual level, allowing to generate measures of associations.

2.3.2. International questionnaires for collecting prevalence data on physical activity

One of the most common and frequently used physical activity questionnaires used on national and international level is the "International Physical Activity Questionnaire" (IPAQ). It was developed to allow for international comparisons of collected physical activity prevalence data. The short version addresses physical activity during the last seven days, the long version is used for in-depth surveys, addressing physical activity comprehensively in general life. Both versions are available for use by telephone and personal interviews as well as self-completion methods and can be applied to 15-69-year-olds. The short version contains definitions of respective PA-intensities and questions on time spend with vigorous activity, moderate activity, walking and sitting, for at least 10 minutes at a time. The answers are given in days per week and hours/minutes per day. The long version contains more detailed questions, sub-divided according to inducement of physical activity (e.g. occupational, transportation, leisure-time activities etc.). The IPAQ Scoring Protocol is adapted to the MET-classification of PA, classified into low/inactive, moderate/minimally active and vigorous/active [32].

The "Global Physical Activity Questionnaire" (GPAQ) was developed by the WHO in the context of the WHO Global Physical Activity Surveillance, and is already used in more than 100 countries [33]. It covers 16 questions on physical activity during work time, transportation, household and leisure-time activities. The questionnaire can be used in personal interviews supported by show cards for better comprehension of questions and response categories. The answers are also given in days per week and hours/minutes per day. The analysis guidelines are phrased following the MET-classifications and WHO-recommendations on PA, participants are either "meeting recommendations" or "not meeting recommendations".

The IPAQ as well as the GPAQ were used in German studies [34, 35]. However, the data of studies using IPAQ or GPAQ do not include a sufficient representative sample of German or NRW data (only small samples with approximately n=400-500 were used) and hence cannot be used in our model. Therefore, we searched and evaluated alternative data sets and surveys in order to acquire physical activity prevalence data for NRW that meet the inclusion criteria described above.

2.3.3. Surveys on physical activity in Germany and NRW

»German Interview and Examination Survey for Children and Adolescents (KiGGS Wave 1)«

From 2009-2012, the Robert Koch-Institute (RKI) carried out the KiGGS Wave 1 with over 12,000 participants aged 0-17 years via telephone interviews [36], as a follow-up of the KiGGS baseline study (2003-2006). A second follow-up, KiGGS Wave 2, started in 2014 and will be completed in 2018 [1].

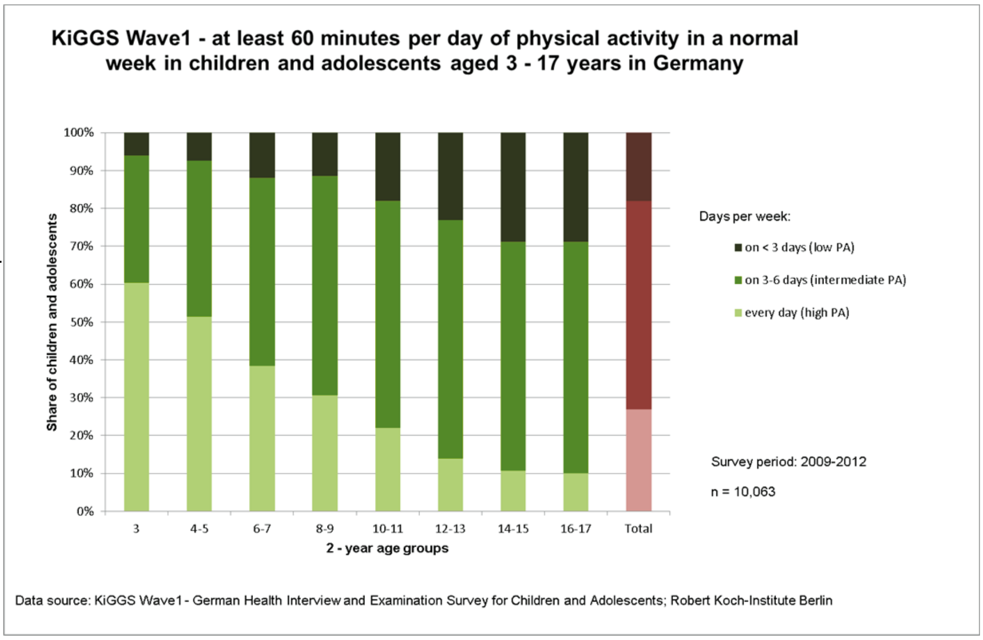
Children and adolescents aged 11 up to 17 years in Germany were i. a. asked about their PA. For children aged 3 up to 10 years[1], parents were asked to answer the question: "On how many days in a normal week is your child/are you physically active for at least 60 minutes a day?". The participants had to choose one out of eight response categories ranging from "on no days" up to "7 days" [37]. The following classification of physical activity amounts is based on the WHO-recommendations for children from 2010 [25]:

Table 3. Classification of physical activity in RKI KiGGS Wave 1 (age 3-17 years)

category	PA – at least 60 min (days/week)
meeting recommendations (active)	7 days
not meeting recommendations, but active	3-6 days
low physical activity (not active enough)	< 3 days

Figure 1 presents the frequency distribution of daily physical activity in German children and adolescents in a normal week, the data was conducted 2009-2012. The WHO recommendation of at least moderate physical activity for 60 minutes every day is being achieved by 60% of the 3-year-olds; this proportion is decreasing continuously in the older age groups: Only every tenth of the 16-17-year-olds is physically active according to the recommendation. When comparing differences between the sexes (not depicted), female teenagers aged 12-17 years show significant higher proportions of low physical activity (30-40%) than their male age-mates (less than 10%).

Figure 1. Comparison of physical activity (at least 60 minutes per day) in a normal week in children and adolescents in Germany by age in RKI KiGGS Wave 1 (age 3-17 years)



»HBSC-study 2013/2014«

The study "Health Behavior in School-aged Children 2013/14" (HBSC) examined individual and social conditions as well as health status and health-related behavior of pupils in 40 countries in Europe and North America (including 5,961 in Germany) aged 11, 13 and 15 years. The WHO-funded survey has been carried out in schools (in 5th, 7th and 9th grade) [38] every four years since 1982. Pupils are asked to fill out questionnaires. Regarding PA, they are asked on how many of the last seven days they were moderately or vigorously physically active for at least 60 minutes. To avoid different interpretations of PA-intensity, the question includes a definition of physical activity as activity, which increases the pulse and gets people out of breath. The answers are given in days per week [39]. Table 4 presents the classification of physical activity used in the HBSC study.

The HBSC-study merely delivers a representative sample for NRW 2010/11. Only ages 11, 13 and 15 are included, which is a very narrow age selection. Reliable prevalence data for children and adolescents in NRW, relating to the coverage of small age increments, can not be derived from this data set.

Table 4. Classification of physical activity in the HBSC-study 2013/2014

category	PA – at least 60 min (days/week)
high PA	5-7 days
intermediate PA	3-4 days
low physical activity	0-2 days

»GEDA – German Health Update«

The RKI conducts telephone health interview surveys in regular intervals: „GEsundheit in Deutschland Aktuell" (GEDA – German Health Update) [2]. GEDA is commissioned by the Federal Ministry for Health and includes ca. 20,000 participants aged 18 years up in each survey sample. The GEDA 2012 study is the third of three representative cross-sectional studies (after GEDA 2009 and GEDA 2010), collecting data on health and health-related behavior (i. a. physical activity) in German adults. For NRW, GEDA provides a representative sub-sample.

To the interviewees, physical activity is defined as any activity that evokes sweating or heavy breathing. The questionnaire includes questions on general physical activity frequency (days/week) and duration (min/day), but not on intensity (light, moderate or vigorous). The latter would be necessary for a classification following the current WHO-recommendations. Classification in line with former recommendations on physical activity from 2004 (at least 30 minutes of moderate to vigorous physical activity on at least 5 days a week) [24] is however feasible. Based on these, the RKI generated a physical activity indicator with 3 categories presented in table 5[2].

[2] The GEDA questionnaire includes questions on sporting activity too. A cross-tabulation analysis with both questions (on general physical activity and on sporting activity) revealed that almost all participants who indicated being active in sports, also indicated being physically active in general. Therefore, the GEDA questions on sporting activities are not considered as a relevant additional data source for physical activity prevalence in Germany.

Table 5. Classification of physical activity in GEDA 2012

category	PA (h/week)
meeting recommendations (active)	≤ 2 ½ h at least on 5 days/week
not meeting recommendations, but active	≤ 2 ½ h on less than 5 days/week
not meeting recommendations (not active enough)	< 2 ½ h per week

The GEDA data 2009-2012 can be merged in order to obtain a solid sample size, and a representative sub-sample for NRW (n = 13,646) can be drawn. The following bar charts present adults' duration and frequency of physical activity in Germany (figure 2) and NRW (figure 3), stratified for 5-year age groups.

The WHO recommendation of at least moderate physical activity for min. 30 minutes on 5 or more days in a normal week is being achieved by ca. 20% of the German adults. From the age of 60 years onwards, this proportion decreases further over age, until less than 10% in the oldest age group (figure 2). Another 20% of all adults achieve the recommended minutes of activity in less than 5 days in a normal week. The majority of 60% report insufficient PA, especially older adults in the retirement age. Figure 3 reveals the situation being slightly more unfavourable for adults in NRW, where 62% report insufficient PA.

Figure 2. Physical activity in adults in Germany by age in RKI GEDA 2009-2012

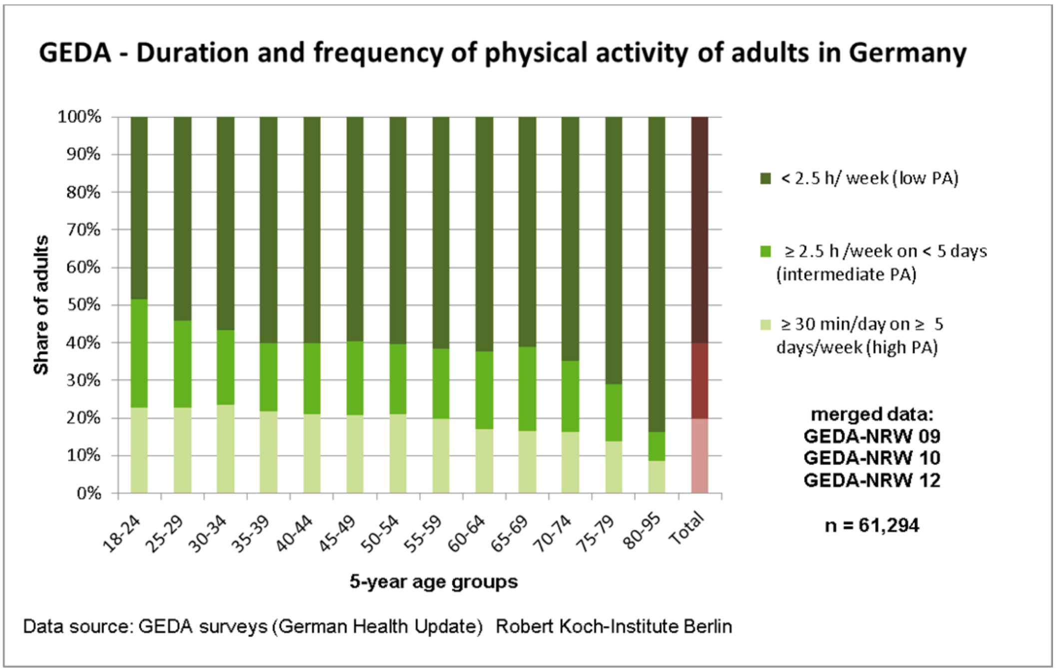
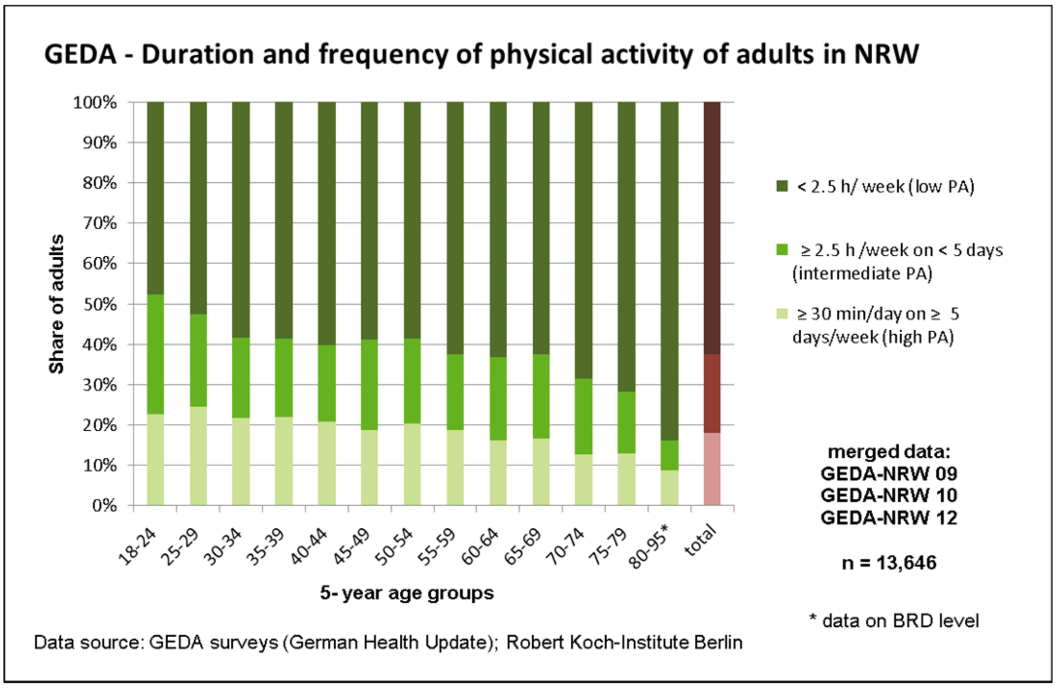


Figure 3. Physical activity in adults in North Rhine-Westphalia by age in RKI GEDA-NRW 2009-2012



»DEGS Wave 1«

The Robert Koch-Institute carried out Wave 1 of the "German Health Interview and Examination Survey for Adults" (DEGS) from 2008 up to 2011. The study includes comprehensive and representative data on the health of adults in Germany. It constitutes the first follow-up of the "German National Health Interview and Examination Survey 1998" (GNHIES 98) from 1997 to 1999. The study population (n = 8,152) consists of newly sampled and re-invited participants from the age of 18 years up, who were interviewed and took part in physical examinations.

DEGS Wave 1 examined health status, health-related behavior, living conditions and health care as well as chronic diseases, mental health and implications of demographic changes for health in Germany. The personal interview questions on physical activity also comprise a definition for the interviewees (physical activity is every activity that evokes sweating or heavy breathing) as well as questions on duration and frequency of physical activity [40]. For DEGS, the same physical activity categories as for GEDA are used (see table 5).

»DEAS«

The representative cross-sectional and longitudinal German Ageing Survey (DEAS) examines data on living conditions in the German population aged 40 years up, funded by the Federal Ministry for Family Affairs, Senior Citizens, Women and Youth (BMFSFJ). The first wave was implemented in 1996, with follow-ups in 2002, 2008, 2011 and recently in 2014, when 6,000 new and

4,000 former participants were interviewed. With regard to physical activity, DEAS asks about sporting activities only, but no data on general physical activity can be derived [41].

»**Microcensus**«

The representative German microcensus questions ca. 830,000 people in ca. 370,000 households in Germany, recently carried out in 2011. Selected households are legally required to participate. The interview includes questions on health-relevant topics like smoking, body measurements and diseases, but not on sports or physical activity [42].

»**SHARE**«

The "Munich Center for the Economics of Aging" (MEA) implemented the international "Survey of Health, Ageing and Retirement in Europe" (SHARE) in Germany. Since 2004, interviewers consulted approximately 123,000 participants (by now) aged 50 years up in 27 European countries (including Germany) and Israel in intervals of approximate two years. The questions asked on physical activity are: "How often do you engage in vigorous physical activity, such as sports, heavy housework, or a job that involves physical labor?" and "How often do you engage in activities that require a low or moderate level of energy such as gardening, cleaning the car, or doing a walk?". The answers categories in each case are: "More than once a week", "Once a week", "One to three times a month" and "Hardly ever, or never" [43]. Because of the exclusion of duration of physical activity (minutes per day) and the missing opportunity to classify the results regarding current recommendations, the SHARE survey can not be considered as a data source for physical activity prevalence modelling.

»**Eurobarometer**«

In 2013, the European Commission tasked to carry out a survey on sports and physical activity [44]. Comparable surveys from 2002 and 2009 preceded [45]. The recent survey, reported in 2014, included 27,919 participants aged 15 years up in 28 EU Member States, who were asked about their sporting and general physical activity in personal interviews. The questionnaire contains 21 questions on physical activity and sporting activity. Data is available for age groups 15-24, 25-39, 40-54 and 55+ only on country-level, thus, no representative data for NRW is provided.

»**NRW Health Survey** «

As a fixed component of the NRW federal health reporting, the NRW Health Survey is conducted once a year, using computer –assisted telephone interviewing. It is commissioned by the Centre for Health in North Rhine-Westphalia and includes 2,000 participants aged 18 years and older [46]. The surveys are representative for the adult population (>18 years) living in private households and using a fixed telephone line. The surveys focus on various main topics as well as subjective health, disease prevalences, health-related behavior, risk factors and socio-demographic characteristics of the interviewees.

In the survey years up to 2015, questions on general physical activity were included, asking for the minutes per unit of at least moderate physical activity in any form. In the survey of 2016, the GPAQ-tool was used in a slightly changed form: questions on the amounts of moderate and vigorous physical activity were asked combined for occupational and leisure-time physical activity, in addition, questions on sitting time were included. The survey of 2017 used the EHIS-PAQ, differentiating between occupational and leisure-time physical activity, and adding questions on muscle- and bone-strenghtening activities.

2.3.4. Characteristics of included and excluded individual-level data sets

None of the identified survey data presented above covers all age-groups of the German or NRW population. Due to this fact, it is inevitable to combine different data sources , in order to add physical activity prevalence data for ages 0-95 to the DYNAMO-HIA model. We assessed all identified survey data at hand on the criteria of suitability introduced in 4.2.1. The results are summarised in table 6.

Table 6. Overview of investigated survey data and assessment of their suitability with regard to physical activity for NRW modelling

selection criteria	KiGGS Wave 1 2009-2012	HBSC-study 2013/2014	GEDA 2009, 2010, 2012	DEGS Wave 1 2008-2011	Microcensus 2011	SHARE 2013	DEAS 2014	Euro barometer 2013	NRW Health Survey 2017
questions on general physical activity included	yes	yes	yes	yes	no	yes	no	yes	yes
following WHO-recommendations on PA	yes	yes	yes	yes	no	no	no	no	yes
large sample size Germany	≈ 10,000	5,961	≈ 63,000	≈ 8,000	≈ 830,000	≈ 4,500	≈ 6,000	1,600	no
representative NRW data	no	no	≈ 13,000	no	yes	no	no	no	=2,000
data available by age and gender	yes	yes	yes	yes	yes	yes	yes	yes	yes
age range	3-17	11/13/15	18+	18+	household	50+ yrs.	40+ yrs.	4 groups	18+
mode	CATI	PAPI	CATI	CAPI	CAPI	CAPI	CAPI & PAPI	CAPI	CATI

For children and adolescents

Despite of the missing opportunity of generating representative data for NRW, the KiGGS Wave 1 data is considered the most suitable for the modelling because of its complete age range 3-17 years and a sample size of ≈ 10,000. For these age groups, the KiGGS data constitutes the best data available. Assuming that physical activity behaviour in German children and adolescents are comparable to those in NRW, KiGGS date will be used.

For adults and the elderly

In the first step of decision, the data sources Microcensus and DEAS were eliminated from further consideration because of their lack of data on general physical activity. The remaining surveys were contrasted with regard to their suitability for NRW modelling. In the next step, the SHARE and Eurobarometer data were not considered further, since they include data on physical activity, but not in accordance to the WHO recommendations. The DEGS survey contains physical activity data in the necessary form on national level, GEDA surveys and the NRW Health Survey deliver equivalent information on NRW level and therefore constitute a preferable option. In the final decision step, we chose to use the merged GEDA-NRW-data of the waves 2009-2012 offering a sample size of over 13,000 individuals for NRW. Hence, these merged data is regarded the most suitable to deliver physical activity prevalence values for adults and the elderly in NRW.

Since both studies, the KIGSS wave 1 and the GEDA NRW collected data on physical activity duration (minutes/week) and frequency (days/week), but not on intensity (moderate or vigorous), we assume not more than moderate intensity (3-6 MET) as an "at least"- approach. Unweighted data were applied due to the necessity to import sex- and age-specific data in the modelling tool. Table 7 presents the final classification of physical activity amounts in both considered surveys.

Table 7. Final classification of physical activity: GEDA studies and KiGGS Wave 1

PA category	GEDA (18+ years)	KiGGS Wave 1 (3 – 17 years)
	PA (h/week)	PA at least 60 min (days/week)
high PA meeting recommendations (active)	≥ 2 ½ h at least on 5 days/week	7 days
intermediate PA not meeting recommendations, but active	≥ 2 ½ h on less than 5 days/week	3-6 days
low PA not meeting recommendations (not active enough)	< 2 ½ h per week	< 3 days

2.3.5. Imputation of prevalence data by single year of age

The KiGGS Wave 1 delivers physical activity prevalence data for children aged 3 to 17 years, but not for the 0-2 year-olds. However, DYNAMO-HIA requires data import for every single year of age from 0-95. Accordingly, we calculate data estimates by applying linear interpolation towards the midpoint values of the neighboring age-groups.

In turn, GEDA NRW delivers physical activity prevalence data for adults 18+ years, but for the NRW population aged 80+ years, the sample sizes in these advanced ages are too small to generate reliable results despite of merging 3 survey years 2009-2012. To bridge this gap, the merged GEDA data on national level were used for the 80-95-year-olds. Again, we applied linear interpolation to obtain prevalence data for every year of age. In addition, polynomial trend lines were appended to improve the data set further.

2.3.6. Discussion of the overall quality of the selected data sets

The large sample sizes of KiGGS Wave 1 and GEDA support statistical accuracy when analysing these data sources.

The quality assurance of the KiGGS Wave 1 contains a large number of measures [1]. Representativeness is given by an ambitious weighting design. It offsets the minor participation in low-educated Germans as well as the design-based oversampling of East Germany [36]. For GEDA surveys, the high quality standard is being maintained by e.g. training measures of interviewees, standardised interviews, plausibility checks, strategies for improvements and control of data quality as well [2].

Nevertheless, it should be noted that all prevalence data used in the modelling originate from self-reported data, referring to the present. We have to be aware that differential as well as non-differential bias is possible, and that the data does not provide information about physical activity as a compounding factor over the life course. Also, lacking data for single age years make it necessary to imply estimation techniques to bridge these gaps, e.g. linear interpolation and data smoothing. German national data has to be used as approximate values where NRW data is missing on a representative level.

For the future, it would be highly desirable to have measured physical activity data at hand, at least internationally standardised survey methods to facilitate comparative analyses.

3. Estimating risk factor-disease relationships

3.1. Selection of health outcomes

The selection of diseases and health outcomes to be included into the modelling was based on the following criteria:

1) best evidence of a risk factor-disease relationship for physical inactivity

2) significant Public Health relevance

3) existence and availability of recent high quality data.

The DYNAMO-HIA model stores data on selected diseases and health outcomes beforehand, that can be extended by the user, whenever reliable data on dose-response-functions between a risk factor and a health outcome is available.

Physical inactivity evidently increases the risk of cardiovascular diseases (CVD), premature all-cause mortality, colon and rectal cancer, breast cancer, diabetes mellitus Type 2 [25].
The selected health outcomes for the model therefore include:

- All-cause mortality
- Colon and rectal cancer (ICD-10 C18-C21)
- Breast cancer (ICD-10 C50)
- Coronary/ischemic heart disease (ICD-10 I20-I25)
- Stroke (ICD-10 I60-I69; G45)
- Diabetes mellitus Type 2 (ICD-10 E11)

3.2. General approach for obtaining data on relative risks

In order to plan successful physical activity interventions and measures that adjust to population needs, it is important to consider the amount and type of activity needed to sustainably reduce the risk of disease incidence. In turn, knowledge about estimates of effect measures, e.g. Relative Risks (RR) or Hazard Ratios (HR), for different health outcomes is necessary to form the base for physical activity interventions. The DYNAMO-HIA tool uses RR/HR estimates to simulate, inter alia, the health impact of interventions, supporting the decision for intervention strategies aiming at maximum health gains of different population sub-groups.

Our final RR/HR estimates for the selected outcomes are based on a comprehensive literature research in different databases (see 2.3.2.). They provide evidence for the direction and size of the relationship between physical activity and the outcomes. The research was guided towards studies and meta-analyses that used a similar way of categorising physical activity (see 1.3.). Publications on the basis of best study design quality and relevance of the study population to the target population of NRW were chosen. The results of the literature research are summarised in table 9.

3.3. Data collection and estimation methods

3.3.1. Criteria for selecting sources of relative risks

The selection of studies and publications to identify the RRs or HRs of disease and mortality outcomes are based on defined inclusion criteria. If available, meta-analyses and reviews of prospective cohort studies are preferred that describe the association between physical activity and a disease, otherwise single full scale studies are acceptable. Multivariate-adjusted RRs or HRs with 95%-confidence intervals have to be provided. The studies should be as recent as possible and include a large sample size, a wide age range and sex-specific data, and present the variables that were adjusted for in the data analyses. The samples should at best be selected in Germany or in the European or Northern American region alternatively. The studies need to compare physical activity amounts grouped in 2 categories (meeting physical activity recommendations vs. not meeting physical activity recommendations) or preferable 3 categories (see table 7), so that intermediate levels of physical activity can be taken into account. If the identified research uses 4 categories (e.g. very active, moderately active, moderately inactive and inactive), the two lowest physical activity categories shall be combined into one category "low/inactive", in order to achieve a 3-category-grouping. If possible, information on age-dependent risk differences will be taken into account.

3.3.2. Search strategy

In a first step of literature research, public health relevant reference websites were visited to identify available data sources and access possibilities. These websites are outlined by Robeson et al. as "facilitating the access to pre-processed research evidence in public health" [47]. Most sources are openly accessible while others provide abstracts and require registration in order to get access to full articles. Table 8 presents the visited websites and their current accessibility status (last visited March 28, 2017).

Table 8. Websites for data research and their accessibility status

Website	Accessibility status
National Guidelines Clearinghouse (NGC) http://guideline.gov	Open access (Medical Guidelines)
Guideline Advisory Committee (GAC) http://www.gacguidelines.ca	Shut down in 2010 due to funding lack (but the GAC will continue its work through project based activity at the Centre for Effective Practice)
National Institute for Health and Clinical Excellence Public Health Guidance https://www.nice.org.uk/guidance	Open access
Registered Nurses Association of Ontario (RNAO) http://rnao.ca/	Open access
Trip Database (filter by guidelines) http://www.tripdatabase.com	Open access
Canadian Medical Association (CMA Infobase: clinical practice guidelines) https://www.cma.ca/en/Pages/cma_default.aspx	Open access
Alberta Medical Association (Towards Optimized Practice) http://www.topalbertadoctors.org	Open access
Health Evidence (summary statements) www.health-evidence.ca	Abstracts available, registration required for getting full text
CDC Guide to Community Preventative Services www.thecommunityguide.org	Open access
The Centre for Reviews and Dissemination (CRD) http://www.crd.york.ac.uk/crdweb	Open access
EPPI-Centre http://eppi.ioe.ac.uk	Open access
The Cochrane Database of Systematic Reviews http://www.cochrane.org/	Limited open access (articles openly accessible in some jurisdic-tions), registration required ; rele-vant reviews included in the Health Evidence registry
National Collaborating Centre for Methods and Tools http://www.nccmt.ca/tools/public_health_plus-eng.html	Only abstracts available
Agency for Healthcare Research and Quality (AHRQ) Evidence-based reports http://www.ahrq.gov/research/findings/evidence-based-reports/search.html	Open access
The Campbell Collaboration www.campbellcollaboration.org	Open access
health.vic https://www2.health.vic.gov.au/public-health/preventive-health	Open access
PubMed https://www.ncbi.nlm.nih.gov/pubmed/	Limited open access (Some articles openly accessible)
ClinicalTrials.gov http://clinicaltrials.gov	Open access, but some study results are not posted

Out of these databases that were easily accessible, we identified PubMed, the Cochrane Library, guideline.gov, guidance.nice.org.uk and Google Scholar as most helpful since they offer a wide range of literature on physical activity linked to health outcomes. In a second step, we identified relevant studies, reviews of the literature and meta-analyses linking physical activity and the selected outcomes, as well as researchers who could be contacted to obtain data or further information. The search consisted of terms related to physical activity ("physical activity", "motor activity", "activity" and "physical inactivity") combined with terms for the outcome ("all-cause mortality", "mortality", "coronary heart disease", "ischemic heart disease", "cardiovascular disease", "stroke", "colon cancer", "rectal cancer", "colorectal cancer", "breast cancer", "mamma carcinoma", "diabetes mellitus", "risk" and "incidence").

3.3.3. Characteristics of included and excluded studies

Relative risk estimates for all-cause mortality, CHD, stroke, T2DM, colorectal cancer and breast cancer were obtained from identified data sources in the course of the literature research. 3-categorial classifications of physical activity were found for all outcomes (4 categories were transformed into 3 categories by combining the two lowest categories into one); consequently, studies and meta-analyses using 2 categories are not discussed further. A summary of the examined data sources and their estimated RRs/HRs is given in table 9.

Most of these studies defined the group of the inactive population as reference category, but the converse is just as possible. In case various sources could be found for an outcome, we collected relevant characteristics such as study design, location, age range, sample size, classification (see also table 1) to select the study approaching most to the criteria with the highest level of evidence. The level of evidence depends especially on the study design [48] (level I: meta-analysis of RCTs/RCTs; level II: meta-analyses of cohort studies/cohort studies). The studies we selected for the modelling are mostly prospective cohort studies and meta-analyses of cohort studies and therefore assigned to level II. In summary, 10 meta-analyses or reviews and 4 single cohort studies were identified meeting the requirements. Most of the review studies and meta-analyses used multivariate-adjusted ratios to form a pooled ratio value, however, we observed considerable differences between the studies regarding the factors that were adjusted for (table 9).

Studies or meta-analyses were excluded if any one of the following criteria applied:

- The outcome measure was prognosis, pre-cancerous lesions or pre-disease markers, because for the calculations data on incident cases are needed;
- Major confounding factors (e.g. age, smoking and BMI) were not considered by the statistical analyses.

Table 10 presents the RRs/HRs finally included in the model, whereby studies using conservative approaches for risk estimates were preferred.

If evidence of incidence risk were unavailable separately for men and women, the same RRs/HRs estimates were applied unless otherwise specified.

Due to the limited evidence available for children and adolescents, it was decided to apply a RR/HR of "1" for individuals under the age of 20 years. For all higher age groups, the same RR estimates were applied, except where we were able to obtain data by age group.

Table 9. Summary of examined studies and relative risk estimates for selected health outcomes by gender and PA-category

					RR / HR estimates per physical activity category					
outcome	**reference (superscript numbers indicate adjustments)**	**study design (FU = Follow- Up) r**	**total n**	**age range**	**high**		**intermediate**		**low/inactive [a]**	
					M	**F**	**M**	**F**	**M**	**F**
all-cause mortality	Andersen et al. 2000[49] [1,2,5,6,7]	cohort study, mean FU 14.5 yrs.	30,640	20-44 45-64 65+ all	0.74** n.s. 0.75** 0.60** 0.71**	0.66** n.s. 0.66** 0.49** 0.59**	0.73** 0.75** 0.62** 0.72**	0.75** n.s. 0.73** 0.52** 0.65**	1.00 1.00 1.00 1.00	1.00 1.00 1.00 1.00
	Löllgen et at. 2009 [50] [1,2,3,6,7]	meta-analysis, 38 cohort studies, median FU 12 yrs.	271,000+	20-80 <65 65+	0.65 0.70 0.55	0.65 / 0.68	0.77 0.81 0.67	0.69 / 0.78	1.00 1.00 1.00	1.00 / 1.00
breast Cancer	Friedenreich et al. 2008 [51] [0]	review study: 34 case-control and 28 cohort studies	/	/		0.74		0.78		1.00
	Lynch et al. 2011 [52] [0]	review study: 73 studies	/	/		0.82		0.85		1.00
	Wu et al. 2013 [53] [1,2,3,4,7]	meta-analysis, 31 cohort studies, median FU n.a.	63,786	20+		0.86		0.97		1.00
	Steindorf et al. 2013 [54] [2,3,4,5,7]	EPIC cohort study in 8 european countries, median FU 11.6 yrs	257,805	35-70 ≤ 50 > 50		0.87* 0.92* 0.86*		0.92* 0.78* 0.94*		1.00* 1.00* 1.00*
colorectal Cancer	Wolin et al. 2009 [55] [7]	meta-analysis, 24 case-control and 28 cohort studies	/	30-50	0.76	0.79	/	/	1.00	1.00
	Howard et al. 2008 [56] [3,7]	cohort study NIH-AARP	488,720	50-71	/	/	0.79***	0.85*** .	1.00	1.00
CHD / IHD	Li & Siegrist 2012 [57] [1,2,3,4,6,7]	meta-analysis, 21 cohort studies	650,000	25+	0.79**	0.71**	0.85**	0.78**	1.00**	1.00**
	Wahid et al. 2016 [58] [1,2,3,4,5,6,7]	meta-analysis, 33 cohort studies, median FU: 12.3 yrs.	1,683,693	25+	0.70[b]	0.70[b]	0.78[b]	0.78[b]	0.87[b]	0.87[b]
diabetes m. Type 2	Stringhini et al. 2012 [59] [1,7]	cohort study Whitehall II	7,237	Ø 49.4	1.00*	1.00*	1.25*	1.25*	1.33*	1.33*
	Cloostermans et al. 2015 [60] [1,2,3,5,7]	meta-analysis, 9 cohort studies, median FU 9.1 yrs	117,878	25-65	1.00*	1.00*	1.08*	1.08*	1.23*	1.23*
	Wahid et al. 2016 [58] [1,2,3,4,5,6,7]	meta-analysis , 3 cohort studies, median FU: 12.3 yrs.	261,618	25+	n.a.	n.a.	0.70[b]	0.70[b]	0.77[b]	0.77[b]
stroke	Lee et al. 2003 [61] [1,2,4,5,6,7]	meta-analysis, 5 case-control and 18 cohort studies	/	45-74	0.73	0.73	0.80	0.80	1.00	1.00
	Diep et al. 2010 [62] [1,2,3,4,6,7]	meta-analysis, 13 cohort studies	255,873	25+	0.81	0.76	0.88	0.99	1.00	1.00
	Li & Siegrist 2012 [57] [1,2,3,4,6,7]	meta-analysis, 21 cohort studies	650,000	25+	0.71**	0.78**	0.73**	0.89**	1.00**	1.00**
	Wahid et al. 2016 [58] [1,2,3,4,5,6,7]	meta-analysis , 33 cohort studies, median FU: 12.3 yrs.	1,683,693	25+	0.76[b]	0.76[b]	0.81[b]	0.81[b]	0.85[b]	0.85[b]

[a] two categories summarised to one [b] ref. category: inactive * Hazard Ratio ** RR for Leisure Time Physical Activity *** regular vs. rarely physical activity

Adjustments: [0]not defined [1]age [2]smoking [3]BMI/body weight [4]alcohol [5]educational level [6]hypertension/blood pressure [7]additional confounders

Table 10. Relative risk estimates for selected health outcomes by gender and PA-category for use in the DYNAMO-HIA tool

outcome	reference (superscript numbers indicating adjustments)	RR / HR estimates per physical activity category with 95% confidence interval					
		male			female		
		high	intermediate	low/inactive[a]	high	intermediate	low/inactive[a]
all-cause mortality	Löllgen et al. 2009 [50] [1,2,3,6,7]				0.65 [0.45-0.93]	0.69 [0.55-0.86]	1.00
	Age < 65	0.70 [0.53-0.94]	0.81 [0.72-0.92]	1.00			
	Age 65+	0.55 [0.31-0.98]	0.67 [0.60-0.81]	1.00			
breast cancer	Steindorf et al. 2013 [54] [2,3,4,5,7]	/	/	/	0.87* [0.79-0.97]	0.92* [0.86-0.99]	1.00*
colorectal cancer	Wolin et al. 2009 [55] [7]	0.76 [0.71-0.82]	/	1.00	0.79 [0.71-0.88]	/	1.00
	Howard et al. 2008 [56] [3,7]	/	0.79*** (0.68-0.91]	1.00	/	0.85*** [0.70-1.04]	1.00***
CHD	Li & Siegrist 2012 [57] [1,2,3,4,6,7]	0.79** [0.73-0.85]	0.85** [0.77-0.93]	1.00	0.71** [0.65-0.77]	0.78** [0.72-1.04]	1.00**
diabetes m. Type 2	Cloostermans et al. 2015 [60] [1,2,3,5,7]	1.00*	1.08* [1.04-1.13]	1.23* 1.09-1.39]	1.00*	1.08* [1.04-1.13]	1.23* [1.09-1.39]
stroke	Diep et al. 2010 [62] [1,2,3,4,6,7]	0.81 [0.75-0.87]	0.88 [0.82-0.94]	1.00	0.76 [0.64-0.89]	0.99 [0.88-1.07]	1.00

[a] Two categories summarised to one [b] ref. category: inactive * Hazard Ratio ** RR for Leisure Time Physical Activity *** Regular vs. rarely Physical Activity

Adjustments: [0]not defined [1]age [2]smoking [3]BMI/Body weight [4]alcohol [5]educational level [6]hypertension/blood pressure [7]additional confounders

4. Potential sources of uncertainty and limitations

The reporting of the techniques used for the collection and categorisation of physical activity data was inconsistent through the included studies. Those reviews and meta-analyses that were chosen to be used in DYNAMO-HIA, report the estimates of the different studies that they are based on, with no other option but to give mean value information, even if these studies used diverse data collecting methods or categorisation on PA. When transferring the impact estimates in the model, it is crucial to consider that the sources used different referent categories. Those estimates can therefore only be understood as the best available approximations of the true underlying associations between physical activity and the onset of different diseases.

Another uncertainty remains, since pooled estimates from meta-analyses are limited due to heterogeneity across the studies that were reviewed. Also, most studies and meta-analyses report estimates that are adjusted for age; only seldomly, different estimates for age groups are reported. In consequence, it remains unclear how estimates vary over age.

The physical activity prevalence data used is self-reported and may be biased [63], and refers to the amount of physical activity in a usual week. For this reason, it is not possible to model physical activity as a compounding risk factor over the live course. It must also be noted that "sedentariness", for the same reason, can not be taken into account for the model, although is has been recognised as in independent risk-factor for several of the modelled outcomes [64].

5. Conclusion

Modelling health outcomes of movement-promoting interventions with DYNAMO-HIA will provide first quantitative indications of future health benefits esp. of activity programs among children and adolescents in NRW, changing their probability to be exposed to different levels of physical activity over the life course. However, modelling outcome validity may be restricted by inconsistent study approaches of physical activity assessment, e.g., movement occasion, that hamper the assessment of the actual dimension of physical activity in surveyed individuals. The quality of modelled outcome estimates, due to increased activity, can considerably be further improved by "physical activity"-indicator standardisation.

Expanding the database of DYNAMO-HIA by a further risk factor like physical activity is feasible, even though challenging, due to the complex structure and manifold approaches to measure physical activity. Compromises need to be made, as well as assumptions related to the transferability of the results of literature research. This has to be kept in mind when interpreting the upcoming modelling results for NRW.

References

1. Holling H, Schlack R, Kamtsiuris P, Butschalowsky H, Schlaud M, Kurth BM. Die KiGGS-Studie. Bundesweit repräsentative Längs- und Querschnittstudie zur Gesundheit von Kindern und Jugendlichen im Rahmen des Gesundheitsmonitorings am Robert Koch-Institut. [The KiGGS study. Nationwide representative longitudinal and cross-sectional study on the health of children and adolescents within the framework of health monitoring at the Robert Koch Institute]. Bundesgesundheitsblatt, Gesundheitsforschung, Gesundheitsschutz. 2012;55(6-7):836-42.
2. Lange C, Jentsch F, Allen J, Hoebel J, Kratz AL, von der Lippe E, et al. Data Resource Profile: German Health Update (GEDA)-the health interview survey for adults in Germany. International journal of epidemiology. 2015;44(2):442-50.
3. World Health Organisation European Centre for Health Policy. Health Impact Assessment: main concepts and suggested approach. Gothenburg consensus paper. Brussels, Belgium: WHO European Centre for Health Policy; 1999.
4. Fehr R, Hurley F, Mekel OCL, Mackenbach JP. Quantitative health impact assessment: taking stock and moving forward. J Epidemiol Community Health. 2012;66(12):1088-91.
5. Amegah T, Amort F, Antes G, Haas S, Knaller C, Peböck M, et al. Gesundheitsfolgenabschätzung. Leitfaden für die Praxis. Wien: Bundesministerium für Gesundheit; 2013.
6. Institute of Public Health in Ireland. Proposed Sugar Sweetened Drinks Tax: Health Impact Assessment (HIA). Technical Report. Dublin: Institute of Public Health in Ireland; 2012.
7. Abrahams D, Pennington A, Scott-Samuel A, Doyle C, Metcalfe O, den Broeder L, et al. European Policy Health Impact Assessment (EPHIA) – A guide. University of Liverpool: IMPACT; 2004 2004.

8. Lhachimi SK, Nusselder WJ, Boshuizen HC, Mackenbach JP. Standard tool for quantification in health impact assessment a review. American journal of preventive medicine. 2010;38(1):78-84.
9. Fehr R, Mekel OCL, Fintan Hurley J, Mackenbach JP. Health impact assessment – A survey on quantifying tools. Environmental Impact Assessment Review. 2016;57:178-86.
10. Lhachimi SK, Nusselder WJ, Smit HA, van Baal P, Baili P, Bennett K, et al. DYNAMO-HIA--a Dynamic Modeling tool for generic Health Impact Assessments. PloS one. 2012;7(5):e33317.
11. Kulik MC, Nusselder WJ, Boshuizen HC, Lhachimi SK, Fernandez E, Baili P, et al. Comparison of tobacco control scenarios: quantifying estimates of long-term health impact using the DYNAMO-HIA modeling tool. PloS one. 2012;7(2):e32363.
12. Holm AL, Bronnum-Hansen H, Robinson KM, Diderichsen F. Assessment of health impacts of decreased smoking prevalence in Copenhagen: Application of the DYNAMO-HIA model. Scandinavian journal of public health. 2014;42(5):409-16.
13. Lhachimi SK, Cole KJ, Nusselder WJ, Smit HA, Baili P, Bennett K, et al. Health impacts of increasing alcohol prices in the European Union: a dynamic projection. Preventive medicine. 2012;55(3):237-43.
14. Lhachimi SK, Nusselder WJ, Smit HA, Baili P, Bennett K, Fernandez E, et al. Potential health gains and health losses in eleven EU countries attainable through feasible prevalences of the life-style related risk factors alcohol, BMI, and smoking: a quantitative health impact assessment. BMC public health. 2016;16:734.
15. Hendriksen MA, van Raaij JM, Geleijnse JM, Breda J, Boshuizen HC. Health gain by salt reduction in europe: a modelling study. PloS one. 2015;10(3):e0118873.
16. Hendriksen MAH, Geleijnse JM, van Raaij JMA, Cappuccio FP, Cobiac LC, Scarborough P, et al. Identification of differences in health impact modelling of salt reduction. PloS one. 2017;12(11):e0186760.
17. Fischer F, Kraemer A. Health Impact Assessment for Second-Hand Smoke Exposure in Germany - Quantifying Estimates for Ischaemic Heart Diseases, COPD, and Stroke. International journal of environmental research and public health. 2016;13(2):198.
18. Institute for Health Metrics and Evaluation. GBD Compare: Viz Hub: Washington University; [updated 2018. Available from: https://vizhub.healthdata.org/gbd-compare/.
19. Hoogenveen R, Boshuizen CH, Doornbos G. Relative risk estimates for physical activity for use in DYNAMO-HIA. RIVM letter report; 2011.
20. de Souto Barreto P. Why are we failing to promote physical activity globally? Bulletin of the World Health Organization. 2013;91(6):390-a.
21. World Health Organization. Global action plan on physical activity 2018–2030: more active people for a healthier world. Geneva: World Health Organization; 2018.
22. Ainsworth BE, Haskell WL, Whitt MC, Irwin ML, Swartz AM, Strath SJ, et al. Compendium of physical activities: an update of activity codes and MET intensities. Medicine and science in sports and exercise. 2000;32(9 Suppl):S498-504.

23. Pate RR, Pratt M, Blair SN, Haskell WL, Macera CA, Bouchard C, et al. Physical activity and public health. A recommendation from the Centers for Disease Control and Prevention and the American College of Sports Medicine. Jama. 1995;273(5):402-7.
24. UK Department of Health PA, Health Improvement and Prevention. At least five a week. London: UK Department of Health, Physical Activity, Health Improvement and Prevention; 2004.
25. World Health Organization. WHO Guidelines Approved by the Guidelines Review Committee. Global Recommendations on Physical Activity for Health. Geneva: World Health Organization; 2010.
26. Davies S, Burns H, T J, McBride M. Start Active, Stay Active: A report on physical activity from the four home countries' Chief Medical Officers. Chief Medical Officers; 2011.
27. Koletzko B, Armbruster M, Bauer C, Bös K, Cierpka M, Cremer M, et al. Ernährung und Bewegung im Kleinkindalter. Handlungsempfehlungen des Netzwerks „Gesund ins Leben – Netzwerk Junge Familie", ein Projekt von IN FORM. Monatsschr Kinderheilkd. 2013;161(12):13.
28. Grams L, Tegtbur U, Kück M, Gützlaff E, Marschollek M, Kerling A. Energieumsatzmessungen unter kontrollierten Bedingungen—Vergleich von Accelerometer, Multisensorsystem und mobiler Spiroergometrie. Deutsche Zeitschrift fur Sportmedizin. 2011;62(6):160.
29. Gaede-Illig C, Zachariae S, Menzel C, Alfermann D. Körperliche Aktivität erfassen-ein Vergleich vom IPAQ-SF und dem SenseWear Pro Armband. Deutsche Zeitschrift für Sportmedizin. 2014;65(6).
30. Hawkins MS, Storti KL, Richardson CR, King WC, Strath SJ, Holleman RG, et al. Objectively measured physical activity of USA adults by sex, age, and racial/ethnic groups: a cross-sectional study. The international journal of behavioral nutrition and physical activity. 2009;6:31.
31. Finger JD, Gisle L, Mimilidis H, Santos-Hoevener C, Kruusmaa EK, Matsi A, et al. How well do physical activity questions perform? A European cognitive testing study. Archives of public health = Archives belges de sante publique. 2015;73:57.
32. Craig CL, Marshall AL, Sjostrom M, Bauman AE, Booth ML, Ainsworth BE, et al. International physical activity questionnaire: 12-country reliability and validity. Medicine and science in sports and exercise. 2003;35(8):1381-95.
33. Cleland CL, Hunter RF, Kee F, Cupples ME, Sallis JF, Tully MA. Validity of the global physical activity questionnaire (GPAQ) in assessing levels and change in moderate-vigorous physical activity and sedentary behaviour. BMC public health. 2014;14:1255.
34. Wallmann-Sperlich B, Froboese I, Schantz P. Physical activity and the perceived neighbourhood environment - looking at the association the other way around. International journal of environmental research and public health. 2014;11(8):8093-111.
35. Schaller A, Dejonghe L, Haastert B, Froboese I. Physical activity and health-related quality of life in chronic low back pain patients: a cross-sectional study. BMC musculoskeletal disorders. 2015;16:62.

36. Lange M, Butschalowsky HG, Jentsch F, Kuhnert R, Schaffrath Rosario A, Schlaud M, et al. [The first KiGGS follow-up (KiGGS Wave 1): study conduct, sample design, and response]. Bundesgesundheitsblatt, Gesundheitsforschung, Gesundheitsschutz. 2014;57(7):747-61.
37. Robert Koch-Institute. Physical activity. Factsheet on KiGGS Wave 1: German Health Interview and Examination Survey for Children and Adolescents – First follow-up interview 2009–2012. Berlin: Robert Koch-Institute (Ed); 2014.
38. HBSC-Studienverbund. Studie Health Behaviour in School-aged Children – Faktenblatt „Methodik der HBSC-Studie". HBSC-Studienverbund Deutschland; 2015.
39. HBSC-Studienverbund. Studie Health Behaviour in School-aged Children – Faktenblatt „Körperliche Aktivität bei Kindern und Jugendlichen". HBSC-Studienverbund Deutschland; 2015.
40. Krug S, Jordan S, Mensink GB, Muters S, Finger J, Lampert T. [Physical activity: results of the German Health Interview and Examination Survey for Adults (DEGS1)]. Bundesgesundheitsblatt, Gesundheitsforschung, Gesundheitsschutz. 2013;56(5-6):765-71.
41. Mahne K, Wolff JK, Simonson J, Tesch-Römer C, für Altersfragen DZ. Altern im Wandel: Zwei Jahrzehnte Deutscher Alterssurvey (DEAS). 2017.
42. Statistisches Bundesamt. Der Mikrozensus stellt sich vor: Statistisches Bundesamt; [Available from: https://www.destatis.de/DE/ZahlenFakten/GesellschaftStaat/Bevoelkerung/Mikrozensus.html.
43. Börsch-Supan A, Kneip T, Litwin H, Myck M, Weber G. Ageing in Europe - Supporting Policies for an Inclusive Society2015.
44. European Commission. Special Eurobarometer 412. Sport and physical activity. European Commission; 2014.
45. European Commission. Special Eurobarometer 334. Sport and physical activity. European Commission; 2010.
46. Rosenkötter N, Annuß R, Borrmann B, Mekel OCL. Regional population health monitoring at the North Rhine-Westphalia Institute for Health, Germany. Public Health Panorama. 2016;2(3):388-93.
47. Robeson P, Dobbins M, DeCorby K, Tirilis D. Facilitating access to pre-processed research evidence in public health. BMC public health. 2010;10:95.
48. Bellomo R, Bagshaw SM. Evidence-based medicine: classifying the evidence from clinical trials--the need to consider other dimensions. Critical care (London, England). 2006;10(5):232.
49. Andersen LB, Schnohr P, Schroll M, Hein HO. All-cause mortality associated with physical activity during leisure time, work, sports, and cycling to work. Archives of internal medicine. 2000;160(11):1621-8.
50. Löllgen H, Böckenhoff A, Knapp G. Physical activity and all-cause mortality: an updated meta-analysis with different intensity categories. International journal of sports medicine. 2009;30(3):213-24.

51. Friedenreich CM, Cust AE. Physical activity and breast cancer risk: impact of timing, type and dose of activity and population subgroup effects. British journal of sports medicine. 2008;42(8):636-47.
52. Lynch BM, Neilson HK, Friedenreich CM. Physical activity and breast cancer prevention. Recent results in cancer research Fortschritte der Krebsforschung Progres dans les recherches sur le cancer. 2011;186:13-42.
53. Wu Y, Zhang D, Kang S. Physical activity and risk of breast cancer: a meta-analysis of prospective studies. Breast cancer research and treatment. 2013;137(3):869-82.
54. Steindorf K, Ritte R, Eomois PP, Lukanova A, Tjonneland A, Johnsen NF, et al. Physical activity and risk of breast cancer overall and by hormone receptor status: the European prospective investigation into cancer and nutrition. International journal of cancer. 2013;132(7):1667-78.
55. Wolin KY, Yan Y, Colditz GA, Lee IM. Physical activity and colon cancer prevention: a meta-analysis. British journal of cancer. 2009;100(4):611-6.
56. Howard RA, Freedman DM, Park Y, Hollenbeck A, Schatzkin A, Leitzmann MF. Physical activity, sedentary behavior, and the risk of colon and rectal cancer in the NIH-AARP Diet and Health Study. Cancer causes & control : CCC. 2008;19(9):939-53.
57. Li J, Siegrist J. Physical activity and risk of cardiovascular disease--a meta-analysis of prospective cohort studies. International journal of environmental research and public health. 2012;9(2):391-407.
58. Wahid A, Manek N, Nichols M, Kelly P, Foster C, Webster P, et al. Quantifying the association between physical activity and cardiovascular disease and diabetes: a systematic review and meta-analysis. Journal of the American Heart Association. 2016;5(9).
59. Stringhini S, Tabak AG, Akbaraly TN, Sabia S, Shipley MJ, Marmot MG, et al. Contribution of modifiable risk factors to social inequalities in type 2 diabetes: prospective Whitehall II cohort study. Bmj. 2012;345:e5452.
60. Cloostermans L, Wendel-Vos W, Doornbos G, Howard B, Craig CL, Kivimaki M, et al. Independent and combined effects of physical activity and body mass index on the development of Type 2 Diabetes - a meta-analysis of 9 prospective cohort studies. The international journal of behavioral nutrition and physical activity. 2015;12:147.
61. Lee CD, Folsom AR, Blair SN. Physical activity and stroke risk: a meta-analysis. Stroke. 2003;34(10):2475-81.
62. Diep L, Kwagyan J, Kurantsin-Mills J, Weir R, Jayam-Trouth A. Association of physical activity level and stroke outcomes in men and women: a meta-analysis. Journal of women's health (2002). 2010;19(10):1815-22.
63. Prince SA, Adamo KB, Hamel ME, Hardt J, Connor Gorber S, Tremblay M. A comparison of direct versus self-report measures for assessing physical activity in adults: a systematic review. The international journal of behavioral nutrition and physical activity. 2008;5:56.

64. Wijndaele K, Brage S, Besson H, Khaw KT, Sharp SJ, Luben R, et al. Television viewing and incident cardiovascular disease: prospective associations and mediation analysis in the EPIC Norfolk Study. PloS one. 2011;6(5):e20058.

List of abbreviations

BMI	Body Mass Index
CAPI	Computer-assisted personal interviewing
CATI	Computer-assisted telephone interviewing
CHD	Coronary Heart Disease
COPD	Chronic obstructive pulmonary disease
GEDA	Gesundheit in Deutschland Aktuell (German Health Update)
GNHIES 98	German National Health Interview and Examination Survey 1998
HEPA	Health-enhancing Physical Activity
IHD	Ischaemic Heart Disease
KiGGS	Studie zur Gesundheit von Kindern und Jugendlichen in Deutschland (German Interview and Examination Survey for Children and Adolescents)
LZG.NRW	Landeszentrum Gesundheit Nordrhein Westfalen (North Rhine-Westphalian Centre for Health)
MET	Metabolic Equivalent of Task
n.a.	not available
DYNAMO-HIA	Dynamic Model for Health Impact Assessment
EU	European Union
HIA	Health Impact Assessment
PH	Public Health
HR	Hazard Ratio
UK	United Kingdom
IPAQ	International Physical Activity Questionnaire
GPAQ	Global Physical Activity Questionnaire
HBSC	Health Behaviour in School-aged Children

DEGS	Studie zur Gesundheit Erwachsener in Deutschland (German Health Interview and Examination Survey for Adults)
NCD	Non-Communicable Disease
NRW	North Rhine-Westphalia
PA	Physical Activity
PAPI	Paper-and-pencil interviewing
RKI	Robert Koch-Institute
RR	Relative Risk
T2DM	Diabetes mellitus Type 2
WHO	World Health Organization

Landeszentrum Gesundheit
Nordrhein-Westfalen

Gesundheitscampus 10
44801 Bochum
Telefon: 0234 91535-0
Telefax: 0234 91535-1694
poststelle@lzg.nrw.de
www.lzg.nrw.de