ORIGINAL RESEARCH

A systematic review of longitudinal cohort studies on the health of migrant populations

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Abstract

Background: Interest in research on migrant health is increasing. The aim of this study is to review sample characteristics, study design, and outcomes (participation and retention rate) of longitudinal studies of the health of migrant populations, and to evaluate whether there are differences in outcomes related to study population and methodology.

Methods: A literature search of prospective longitudinal studies on migrant health was performed in Medline and Web of Science, with 545 articles retrieved. Key informants were contacted when needed. After identification, screening, and eligibility, nine articles were included.

Results: The most commonly studied topics were occupational and mental health (44.4%). Two studies had sample sizes of >5000 subjects, and 4 studies recruited families. One study targeted undocumented workers. Study duration was 2 years in 4 studies with 1 follow up wave. Two studies collected biological samples, and 2 used incentives. Higher participation (PR) and retention (RR) rates were found in studies of families, studies of groups perceived to be at high risk, studies where the researchers had close community ties, and studies where complete contact information had been obtained by the researchers. Lower PR and RR were associated with large time delays between waves and targeting irregular workers. Respondent driven sampling (RDS) was successful in reaching hidden populations.

Conclusions: Identification of documented migrants through governmental records, early follow up, use of a variety of strategies (including digital technologies) to locate participants and maintaining personal relationships are the main factors influencing PR and RR. It is essential to consider them when planning research and to

foresee and plan for the difficulties that might arise during a longitudinal study.

Keywords: Longitudinal Studies; Cohort Studies; Follow-Up Studies; Emigration; Immigration; Health

Research highlights

- It is crucial to anticipate and solve difficulties during early phases of research.
- Contemporary longitudinal studies call for creative approaches to deal with the complexity of studying hard-to-reach migrant populations.
- Family cohorts have resulted in satisfactory participation and retention rates.
- Proximity to the community and the collection of detailed contact information can increase retention rates.

Introduction

Research on migrant health is receiving increasing attention from researchers and health institutions worldwide.[1] Following the exponential growth of global migration[2] and evidence that the health status of migrants declines over time, there are calls for increased involvement in research on the health of these populations.[2,3] Studies have shown health inequalities between migrants and native populations.[5,6] Recently, theoretical models have acknowledged the complex and multifactorial dimensions of migration and health and have incorporated a life course approach[7]; this takes into account the changing nature of health determinants during all the stages of the migration process.

Research has only recently begun to examine the reasons for differences between migrants and natives with respect to health outcomes, healthcare use, and quality of care. So far, most studies have been descriptive in nature rather than explanatory.[3] Longitudinal studies are needed in order to appropriately address the complex and dynamic relationship between migration and health within a broader context. Longitudinal evidence on migrants comes largely from cohorts chosen from the general population or from cohorts with specific diseases but which were not primarily designed to study migrant populations.[9-11]

Longitudinal studies offer the advantage of addressing how the health problems faced by migrant populations change over time and throughout the migration process. Identifying associations between demographic factors, such as length of residence in the host country, and exposure to stressors[12] could significantly increase the current understanding of the risk profile for the major causes of disease affects migrants.[13] This knowledge would provide a firm basis for the development of effective preventive and treatment strategies.[8,14]

Prospective cohort studies of migrant populations are scarce, and they involve important logistical and financial challenges. Migrants are considered a hard-to-reach population. Information on migration status and migration patterns is generally not available.[13] Recent migrants and those without legal status may elude official data sources and require active and creative sampling and recruitment approaches.[13,15] Migrants may be more often lost to follow up due to mobility, work instability, or fear of contact with unfamiliar institutions in the host country.[16,17] All these factors, impact participation and retention rates in longi-tudinal studies targeting migrants.[18]

The aim of this systematic review is to compare longitudinal studies of migrant populations and evaluate whether population characteristics, sample frame, recruitment, cohort design, and data collection methods have an influence on participation rate and follow-up. This research was supported by funds PI13/01962 and PI14/01146.

Table 1: Search Strategy:
Filters, MeSH terms, key words and relevant text terms used in the search strategy through PubMed and Web of Science

Search filter	Medical Subject Headings [MeSH terms], key words and free relevant text terms
Type of study	Longitudinal Studies, Cohort Studies, Follow-Up Studies, Prospective Studies, (Not) Cross-Sectional Studies, (Not) Clinical Trials
Migrant population	Emigration and Immigration, Emigrants and Immigrants, Transients and Migrants, Ethnic Groups
Health condition	Health, Health Status Indicators, Health Services Accessibility, Health Surveys, Socioeconomic factors, Prevention and control

Figure 1: Selection process to identify migrant cohort studies through a systematic search in PubMed and Web of Science

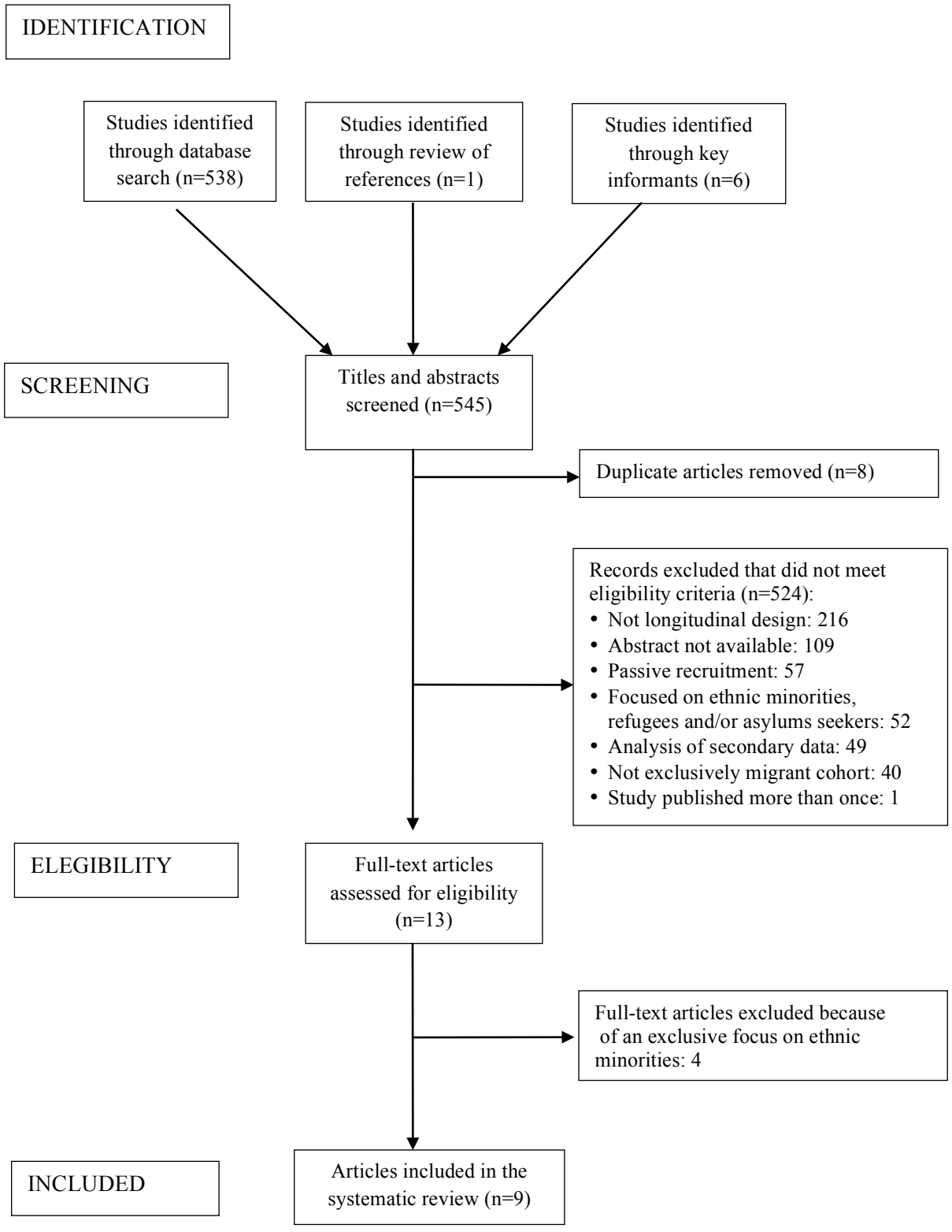

Table 2: Characteristics of selected studies (n=9)			
First author Publication year	**Study location**	**Health condition studied**	**Study population and demographic characteristics**
Chou KL[24] 2006	Australia	Mental health	Newly arrived migrants over 50 years old, arrived between 1999 and 2000 in Australia, settled in capital cities and major urban areas.
Stoecklin-Marois MT[25] 2011	USA	Occupational and environmental health	Latino farm workers living in Mendota, California.
Cooper SP[26] 2006	USA	Occupational health	Hispanic farm workers living in Starr County followed for an average of 17 years.
Delcos CE[27] 2011	Spain	Occupational health	Migrant workers from Colombia, Ecuador, Morocco, and Romania, living at least one year in Spain. 30% irregular migrants.
Ristner M[28] 1997	Israel	Mental health	Recent immigrants from the former Soviet Union living in Jerusalem.
Cwikel J[29] 1997	Israel	Mental health	Migrants from former Soviet Union from areas both exposed and non-exposed to Chernobyl accident.
Cobb-Clark D[30] 2001	Australia	Occupational health and settlement experiences	Recently arrived and off-shore documented migrants, living in capital cities and major urban areas.
Kuhns LM[31] 2007	USA	Sexual risk behavior among Latino GBT	Latino GBT from 18 to 73 years old living in Chicago and San Francisco
Stronks K,[32] 2013	Holland	Mental health, cardiovascular, and infectious diseases	Afro-Caribbean Surinamese, South Asian-Surinamese, Turkish, Moroccan, Ghanaian, and ethnic Dutch from 18 to 70 years old living in Amsterdam. Migrant generation recorded (partner, parents and offspring of case index)

GBT: gay, bisexual men, or transgender male-to-female.

Methods

Search strategy

Between December 2012 and March 2013 a systematic search was conducted in Medline (PubMed) and Web of Science (Web of Knowledge), with no language or date restrictions. Sources were selected based on their prominence in the health area at the international level. Search was done according to database characteristics. (Table 1) The Boolean operators "AND" and "OR" were used to retrieve all available scientific literature.

Selection criteria

For the purposes of study selection migrants were defined as people with a country of birth or nationality different than the country of study.[19] The identification and screening of article titles and abstracts was conducted by two independent researchers (MS y CH). Selected full text articles were independently screened to assess their eligibility. Inclusion criteria were: 1) prospective longitudinal design, 2) study population focused on migrants, and 3) examination of aspects related to health, such as health status, access to or use of healthcare services. Exclusion criteria were: 1) non-longitudinal design, 2) abstract not available, 3) passive recruitment, 4) not exclusively migrant cohort, 5) analysis of secondary data (given that our main interest was in active strategies to reach migrants); 6) focus on ethnic minorities, refugees and/or asylum seekers since they present very particular characteristics that increase their health vulnerability[20,21]; 7) for studies with more than one publication, we selected only the publication that contained the most detailed methodological description. Consensus on the articles for inclusion was reached through discussion. In addition, the reference list of obtained papers was reviewed in order to identify potential additional relevant articles. Authors were contacted when relevant information was missing. Citations were uploaded into an EndNote XI library where duplicates were removed.

Outcome measures: Participation (PR) and retention (RR) rates

PR was defined as the proportion of all cases interviewed to all eligible units ever contacted, and RR was defined as the proportion of known respondents who were reached by the survey and participated after initial assessment.[22] These two measures were selected because they reflect the difficulties in identifying, enrolling, and maintaining migrants in longitudinal studies and suggest study methodology success and validity. In addition, their homogenous definition allows comparison between studies.

Data extraction and synthesis

Data was extracted into a structured form: 1) study information (author, year of publication, study location, funding sources); 2) health condition assessed; 3) sample characteristics: sampling unit (persons or families), sampling frame, sampling recruitment, sample size (number of eligible participants achieved, or the achieved sample size where information on the eligible sample size was not provided), and sociodemographic characteristics of the participants; 4) study design and use of control group; 5) study time-frame including length of the study in years, number of data collection waves and interval time between waves; 6) recruitment strategy including sampling approach, contact method, data collection instruments, biological samples and measurements, language, and use of incentives; and 7) outcome rates: PR and RR. We accepted each study's own definition of RR as this varied based on the time point used to measure these rates.

Methodological quality of included studies

We used the Newcastle-Ottawa Quality Assessment Scale for Cohort Studies (Newcastle-Ottawa), a checklist to assess the methodological quality of the included studies.[23] Specifically, this simple checklist uses a star system to assess three general areas: selection of study groups, comparability of groups, and ascertainment of outcomes. This instrument can be used in a systematic review to assess the quality of non-randomized studies.

RESULTS

Literature search

Figure 1 outlines the selection process for identifying references through the literature search. A total of 545 articles were initially identified, 537 remained after removing duplicates.[8] Of these, 524 (97.6%) were excluded and 13 (2.4%) full text articles were obtained and assessed for eligibility. After full review, an additional 4 (0.7%) articles which focused on ethnic minorities were excluded. Finally, 9 (1.7%) articles were considered eligible for data extraction. All of the studies were published in English.

Study Characteristics

Three of the nine articles (33.3%) were conducted in United States. (Table 2) All studies received public funding and three obtained additional private funding (Stoecklin-Marois *et al.*, Ristner *et al.* and Stronks *et al.*). The most frequently studied health topics were occupational and mental health issues. Two recent studies, Kuhns LM *et al*. and Stronks K *et al*., focused on sexual behaviour, cardiovascular, and infectious diseases.

Sample characteristics

Migrants were described in terms of region or country of origin, age, and duration of residence according to the information available in each article. (Table 2) Chou KL and Cobb-Clark *et al.* surveyed recent migrants whereas Delclos *et al.* included those living in the host country for at least one year. Four studies focused on especially hard-to-reach migrant populations such as undocumented (n: 1), agricultural farm workers in the U.S. (n: 2), and Latino gay and bisexual men and transgender people (GBT) (n: 1).

The sample size at selection is defined as the eligible achieved sample size or the achieved sample size, according to the information provided by the articles. Sample size varied greatly from 267 subjects to 30,000. (Table 3) Two publications, Cooper *et al.* and Stronks *et al.*, detailed sample size calculations and Stronks *et al*. increased sample size to compensate for potential loss to follow-up.

Four studies sampled families. (Table 3) In Stoecklin-Marois *et al.* and Cooper *et al.* families were defined as domiciles composed of a head of household and his/her relatives. Both excluded unaccompanied male households. In Stoecklin-Marois *et al.* the head of household provided

information on children, in Cooper *et al.* the mother provided information on all family members. In Cobb-Clark *et al.* a family unit consisted of all individuals included in the same visa application. Both primary applicants and spouses were interviewed and the primary applicant provided information about other family members. Stronks *et al.* used an extended definition of family, including partner as well as parents and siblings of an index participant, provided they all lived in the same city.

Among those studies that included recent and documented migrants, PR was 58.9% and RR 72%-86%. (Table 4) The study on undocumented migrants resulted in PR of 57% and RR of 30%. Studies that sampled families reached PR ranging from 20% to70% and RR from 72% to 95.1%.

Table 3: Main methodological characteristics of included migrant cohort studies (n=9)

Author Year of Publication	Duration (yrs) # of waves Gap between waves (months)	Sampling frame	Sample size and sampling recruitment	Incentives	Data collection	
					Questionnaire	Biological measures
Chou KL[24] 2006	Duration: 2 Waves: 1 Gap: 12	Government record (Settlement Database and first and second waves of the LSIA[a] (Panel 2)	431 migrants. Random sample	NS[b]	Face-to-face interview and self-administered questionnaire (LSIAII), link to governmental records	No
Stoecklin-Marois MT[25] 2011	Duration: 8 Waves: 2 Gap: 19, 17	Census blocks	843 migrants, 467 heads of household and 376 spouses (55% from Mexico, 35% from Central America and 10% from USA). Field strategy: door-to-door enumeration. Random sample	NS	Face-to-face interview	Anthropometric measurements, spirometry, urine sample, air sample, study of atopia with RAST[c]
Cooper SP[26] 2006	Duration: 2.5 Waves: 2 Gap:12, 24	Government record (New Generation System)	267 migrants. Random sample	15$ gift card in each follow-up survey	Face-to-face interview	No
Delcos CE[27] 2011	Duration: 4 Waves: 1 Gap: 48		2434 migrants. Field strategy: block-walking approach. Convenience sample	No	Face-to-face interview	No
Ristner M[28] 1997	Duration: 1 Waves: 1 Gap: 12	List of recent migrants	419 migrants. Field strategy: door-to-door case finding. Convenience sample	NS	Face-to-face interview and self-administered questionnaire	No
Cwikel J[29] 1997	Duration: 2 Waves: 1 Gap: 12	Government record, recorded respondents of a previous massive call, and personal contacts	708 migrants, 374 from exposed areas to Chernobyl accident, 334 from non-exposed areas. NS	NS	Face-to-face interview	Blood pressure

Table 3: Main methodological characteristics of included migrant cohort studies (n=9)						
Cobb-Clark D[30] 2001	**Cohort A:** Duration 5 Waves: 2 Gap: 12, 36 **Cohort B:** Duration: 2 Waves: 1 Gap: 12	Government record (LSIA[c] I and LSIA II)	**LSAI 1: 5192** primary applicants and 1837 migrating-unit spouses. **LSAI 2: 3124** primary applicants and 1094 migrating-unit spouses. Random samples	NS	Face-to-face interview	No
Kuhns LM[31] 2007	Duration: 1 Waves: 2 Gap: 3,6.	-	643 migrants, 320 in Chicago, 323 in San Francisco. Respondent driven sampling (RDS). Convenience sample	At the baseline data collection: 50$ for completing the survey and 20$ for each peer recruited (up to 60$), refreshments	Self-administered questionnaire (online)	No
Stronks K[32] 2013	Duration: in recruitment Waves: NS Gap between waves: 60 months, Started in 2011. Currently enrolling.	Municipality registry	Overall 30.000 people. 5000 from each ethnic group: Afro-Caribbean Surinamese, South Asian-Surinamese, Turkish, Moroccan, Ghanaian and ethnic Dutch. Random sample	NS	Self-administered questionnaire (on paper or online), link to local general practitioner, hospital discharge, pharmacy, health care insurance, and vaccination registries	Anthropometric measurements: body fat percentage, blood pressure, Biological samples: blood, morning urine and faeces samples, nasal and throat swabs, and vaginal swab (self-administered)
Notes: a: LSAI: Longitudinal Survey of Immigrants to Australia b: NS: not specified, c: RAST: Radioallergosorbent Test						

Cohort design and time frames

Ten cohort studies were analysed within the nine included articles. (Table 3) Cobb-Clark *et al.* recruited two separate entry cohorts; the first remained in the study for five years and the second for 18 months.

All studies had closed fixed cohorts (i.e. once the cohort was defined by enrolling subjects and follow up begins, no one else can be added). Five (50%) cohorts had one follow-up wave, four (40%) two follow-up waves, and one (10%) is currently conducting recruitment of participants. The length of study varied from one to eight years; most lasted two years (n: 4). The most frequent interval between baseline and the first follow-up wave was twelve months (60%, n: 6), and for subsequent follow-up waves the interval ranged from 3 to 24 months. The currently active cohort, Stronks *et al.,* began recruitment in 2011 and is planned to last for 5 years (first results published in 2014[33]). (Table 3)

RR after first follow-up varied from 30% to 95.1%, and after second follow-up from 72% to 94.5%. Taking into account time after baseline assessment, RR was 83% at 3 months, 80% at 6 months, 49%-95.1% at 12 months, 94.5% at 24 months, 72% at 36 months, and 30% at 48 months.

Sampling frame and recruitment strategy

Studies identified migrants from governmental records (n: 4), a municipality registry (n: 1), census blocks (n: 1) and a previous list (n: 1). (Table 3) Two studies did not specify the sampling frame. In terms of field recruitment strategies, Ristner *et al.* performed door-to-door case-finding, Delclos *et al.* employed a block-walking approach, Stoecklin-Marois *et al.* a population-based household sampling strategy, and Kuhns *et al*. used respondent driven sampling (RDS). Two studies used linkages with other sources. Cobb-Clark D. drew data from administrative databases. Stronks *et al.* accessed data from a local general practitioner, hospital discharge records, a pharmacy, a healthcare insurance company, and vaccination records. Five studies (Chou KL, Stoecklin-Marois MT, Cooper SP, Cobb-Clark D, Stronks K) recruited random samples, 3 (Delcos CE, Ristner M, Kuhns LM) convenience samples, and one (Cwikel J) did not specify.

Studies that used governmental records to identify eligible participants reached PR of 57.7% to 95.1% and RR of 59.8% to 94.5%. Those using census blocks resulted in PR of 70%. Use of a municipality registry led to PR of 20%-30%. Among the field recruitment strategies used, the block walking approach reached a PR of 57% and an RR of 30%, household sampling strategy a PR of 70%, RDS a PR of 88% and an RR of 80%-83%, and door-to-door case finding a PR of 91.7% and an RR of 49%.

Data collection

Seven studies conducted face-to-face interviews with PR's of 57% to 91.7% and RR's of 30% to 95%. Two conducted self-administered and online questionnaires with PR's of 20% and 88% and RR's of 80-83%. (Table 3) Only Cwikel *et al.* included validated measures for migrants. In Delclos *et al.* surveyors presented a letter of commitment offering confidentiality. Questionnaires were performed in the host country language (Chou KL, Delclos et al) with a PR of 57% and an RR of 30-83.3%, in the migrant's native language (Stoecklin-Marois *et al.* and Ristner *et al.*) with PR's of 70% and 91.7% and an RR of 49%, both in English and in Spanish (Kuhns *et al.*, Cooper *et al*.) with PR's of 57.7% and 88% and RR's of 80% and 95.1%, and in over 50 languages (Cobb-Clark *et al.*) with a PR of 58.9% and an RR of 72% to 86%. Surveyors were foreign-born with the same origin as the study population in three studies (Delclos *et al.*, Stoecklen-Marois *et al.*, and Stronks *et al*) reaching a PR of 20%-70% and an RR of 30%. Translation and interpretation support provided by family members and friends was used in two studies (Chou KL and Cobb-Clark *et al.*) and attained a PR of 58.9%-83.3% and an RR of 72-86%. Bilingual research staff was used in one study (Kuhns *et al*), with a PR of 88% and an RR of 80-83%.

Follow-up

Methods for contacting migrants for follow-up included phone calls (Delclos *et al.*), as well as phone and email messages, or repeated mailings over four weeks (Kuhns *et al*.). Using phone calls as contact method obtained a PR of 57% and RR of 30%, while using phone and email messages or mail reached a PR of 88% and RR of 80-83%.

Collection of biological data and specimens

Biological data was collected in several studies; this included anthropometric measurements (Stoecklen-Marois *et al.* and Stronks *et al*), blood pressure (Cwikel *et al.*), clinical tests including arteriography, heart haemodynamic study, electro-cardiogramz, spirometry, air samplings and RAST to study atopia (Stoecklen-Marois *et al.* and Stronks *et al*). Biological samples were also collected: these included blood, feces, nasal, throat and vaginal swabs, and urine (Stoecklen-Marois *et al.* and Stronks *et al*). Performing clinical tests and obtaining biological samples reached PR of 20-70%.

Use of incentives.

Incentives were provided in two studies (Cooper *et al.* and Kuhns *et al.*).

Quality of included studies

Overall quality of the included studies was high, bearing in mind that these were observational studies with an inherently high risk of bias. The cohorts were representative of the type of migrants and the context in which the study was conducted, although only five studies used random samples. Four studies compared migrants with natives, and seven compared migrants from different migrant groups, established by country of origin (44.4%, n: 4), city of residence (22.2%, n: 2), or by exposure to a risk factor (11.1%, n: 1). (Table 3) Outcome

Table 4 Participation rate and retention rate after follow-up waves		
Author	**Participation rate**	**Retention rate after follow up**
Chou KL[24]	NS[a]	83.3%
Stoecklin-Marois MT[25]	70%	NS[a]
Cooper SP[26]	Wave 1: 57.7% Wave 2: 59.8%	Wave 1: 95.1% Wave 2: 94.5%
Delcos CE[27]	57%	30%
Ristner M[28]	91.7%	49%
Cwikel J[29]	91%	73%
Cobb-Clark D[30]	LSIA 2: 58.9%	Wave 1 LSAI[b] 1: 86% Wave 2 LSAI 1: 72% LSAI 2: NS
Kuhns LM[31]	88%	Wave 1: 83% Wave 2: 80%
Stronks K[32]	20-30%	NA[c]
Notes: [a]NS: not specified, [b]LSAI: Longitudinal Survey of Immigrants to Australia, [c]NA: not applicable		

assessment in all studies was performed adequately. Although only one study specified that it used validated scales, the rest of the studies made efforts to improve the quality of the outcome assessment by using translated questionnaires or surveyors with the same national origin.

Discussion

Our review identified important changes over time in terms of complexity, challenges, and creativity in the design of longitudinal studies. Early studies had small samples and only one or two follow-up waves. In contrast, more recent cohorts target large samples (>5000) and go beyond the single individual to recruit families. Recent studies have sought to include specific populations such as irregular workers who are hard to reach, as well as important efforts to collect a variety of biological measurements and biological samples; these provide independent and objective measures of health variables in contrast to self-reported survey questionnaire data. However, such data collection is expensive, time consuming,[14] and adds complexity to the fieldwork. Another important change is the planning of longer and even unrestricted follow-up time frames (subject to funding availability). Overall, the most frequent topics studied were occupational health and mental health. In some studies on these areas migrants showed worse health outcomes[34-37] or evolution[38] than natives.

Interestingly, the HELIUS study[32] has adopted a new multigenerational approach by looking at family members across generations. This will allow for comparison between first generation migrants, who generally migrate at a very young age, and the second generation (offspring of migrants) who were born in the host country.

Another example that illustrates the adoption of a creative approach is the Babi Studie cohort (Bielfeld, Germany), that began in 2013 and plans long-term follow-up. The study recruits mother/newborn pairs in order to study determinants of health inequalities between migrants and the general population.[7]

PR and RR varied widely among the studies, from 20%-91%, and from 30%-95,1%, respectively. Some studies were close to the outcome rates reported by a longitudinal study of the general population. The Millennium Cohort Study included 19,244 families living in United Kingdom, with oversampling of those with minority ethnic backgrounds); the PR was 85%[39] and the RR 78%.[40] Sample attrition is a major issue for longitudinal research, as participants may choose to discontinue their participation or may no longer be able to participate due to relocation, illness, or death. A larger baseline sample size offers some protection for the viability of the study over time. This can counteract sample loss, but at the same time, sample size issues must be related to the purpose and design of the study, and to how the population of interest is defined.[14]

In the review, documentation status of migrants seems to influence RR (30% in undocumented vs. 86% in documented) rather than PR. RR is likely to decrease after more than 24 months between basal assessment and follow-up. Using governmental records, and therefore, identifying documented

migrants, is able to reach the highest PR (up to 95.1%) and RR (up to 94.5%). High PR was also attained by door-to-door case finding (91.7%). RDS also attained high rates of both PR and RR.

Lower PR were seen in studies using self-administered questionnaires; this suggests that personal contact between researchers and participants is a key factor in achieving high PR and RR. There were no clear trends about how to deal with language barriers.

Follow up should be done within 24 months after initial assessment. Employing more than one contact method and using digital technologies (email) may lead to higher RR than using only phone calls.

The highest PR (91%) was obtained in studies on migrants from areas with exposure to the Chernobyl accident (Cwikel J *et al.*). The second highest PR was attained by a study of mental health among recent migrants (Ristner M *et al.*). This might indicate that self-perceived illness severity or the risks associated with a given illness might play a role in the PR.

The type of migrant population addressed may also influence outcome rates. For example, the two cohorts that included families both reached PR and RR above 85%, probably due to the fact that families constitute a more settled population than individual migrants. In particular, by recruiting mothers (Cooper SP *et al.*) Cooper and his colleagues were able to maintain a follow-up rate of more than 95%.

In contrast, hidden populations, such as irregular migrants, produced the lowest participation (57%) and retention rates (30%) of the included studies. Reasons given by Latino farm workers in the U.S. for declining participation (Stoecklen-Marois *et al.*) included distrust, lack of time, lack of interest, and reluctance to disclose data. Other reasons that might result in the reluctance of "hidden" populations to participate are language and cultural barriers, and fears of legal consequences or deportation associated with migrant status.

Other studies of populations typically considered hard-to-reach have resulted in more satisfactory outcome rates. This is the case of the Latino GBT participants who were recruited through the RDS strategy, which resulted in both participation and retention rates of over 80%. RDS is an innovative chain referral method that uses the participants' social networks.[41-44] The recruitment process is restricted at each wave of implementation to calculate selection probabilities that maximize the chance of obtaining a demographic and socially diverse sample.[45] By accessing respondents through their own social networks, the sample is potentially extended throughout a population, in this case, a key population at high risk for HIV. RDS has been successfully conducted within hidden sub-populations of migrants, such as irregular workers[46] and sex workers.[47] Decisions about methodology are strongly linked to the content of the data that needs to be collected, the planned analysis, and the resources that are available to conduct the research.[14]

Another well-known strategy used to achieve cohort participation and retention is the proximity and good relations of the researchers with the target community.[48] However, this strategy is underused, and only the RDS study conducted formative research at the pre-implementation stage.[49] Researchers involved GBT participants in the discussions related to planning, logistics, and predicted outcomes of the study. On the other hand, Stronks K *et al.* reported an expected PR around 20-30%, which may have been influenced by the fact that the study contact with participants was limited to mail (a written invitation to participate). Three studies attempted to gain proximity to the migrant community by using surveyors of the same national origin as the study population. This ensures similar language, cultural and life experiences, and perhaps greater trust. There was no consistent trend on outcome rates. It would seem that proximity to the study population is perhaps not sufficient to improve recruitment and retain participants.

The frequency of data collection, that is, the number of waves and interval time between waves, is a well-established factor that influences follow-up rates.[50] In our review the study with the longest temporal gap between waves (4 years) showed the lowest retention rate.

Lastly, a plan to obtain detailed contact information and the use of diverse methods to contract participants (including the Internet) appears to be crucial for successful follow-up of migrants.[14,51] In Kuhns *et al.* the strongest predictor for retention was the number of pieces of contact information provided by participants (e.g. home address, telephone numbers, email address, names and phone numbers of friends, relatives and boyfriends). The influence of the large quantity of information available to the researchers is reflected

in the RR obtained in our review. Delclos had only phone numbers as contact information, and this might have accounted for the study's inability to sustain contact with subjects and the fact it attained the lowest RR among reviewed studies. It is crucial to gather this information in advance and to devise a complete tracking and follow-up strategy to minimize avoidable loss to follow up. Stronks *et al.* had access to additional sources of health data, which complemented the information collected from participants; the researchers could even continue to collect information on those cases that were lost to follow-up.

Economic incentives may improve outcome rates for participants from low socioeconomic strata.[31] However, in previous qualitative research migrants preferred not to receive incentives as they perceive them as necessitating a greater commitment to the study.* It is very difficult to derive conclusions on this question from our data given that only two studies provided information on incentives. Nonetheless, both attained high follow-up rates.

Collecting biological measurements may also have an impact on outcome rates; it could increase the PR and RR by offering the expectation of a complete medical examination. It might also decrease them due to the investment of time needed. Our review was not able to identify evidence about the possible impact of collecting biological measurement on outcome rates.

Although multiple funding sources are often needed in order to undertake longitudinal studies, and many projects seek out new funding as initial resources are exhausted, only a minority of the included studies had multiple sources of funding. This may reflect a lack of interest in migration and health as a priority area for funding institutions. Lack of continuity in funding, as well as political, social, and administrative changes, are also potential problems for completing longitudinal studies. Continuity of financing and commitment and persistence of project staff have been identified as essential for longitudinal projects.[14,51]

Although a systematic and exhaustive literature search was performed, this study may not have identified all relevant studies.

Conclusions

Recent cohort studies of migrant population have employed sophisticated and innovative designs. Funding is basic so that longitudinal studies can continue to their completion. Funding and logistical challenges associated with cohort studies may be increased by the difficulties in access to and retention of migrant populations. Main factors influencing PR and RR are the identification of documented migrants through governmental records, early follow up, use of a variety of strategies, including digital technologies, to locate participants and maintaining personal relationship throughout the study. Nevertheless, it is essential at the early stages of a research project to consider the factors influencing PR and RR and to foresee and plan for the difficulties that may arise.

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