Outcomes associated with higher relational continuity in the treatment of persons with asthma or chronic obstructive pulmonary disease: A systematic review

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Summary

Background Asthma and chronic obstructive pulmonary disease (COPD) are chronic conditions where relational continuity of care, as in regularly meeting the same health care provider, creates opportunities for monitoring and adjustment of treatment based on an individual's changing needs, potentially affecting quality of delivered care. The aim of this systematic review was to investigate the effects of relational continuity in the treatment of persons with asthma or COPD.

Methods Eleven databases (CINAHL, Medline, PsycINFO, Scopus, Embase, Cochrane Library, Database of Systematic Review of Effects, DARE, Epistemonikos, NICE Evidence Search, KSR Evidence and AHRQ) were searched between January 1, 2000, and February 1 - 4, 2021, for controlled and observational studies about relational continuity and health outcomes for persons with asthma and/or COPD. Inclusion criteria were studies investigating an index or aspect relevant to relational continuity between a health professional/team of health professionals and patients. After screening, and assessment of study relevance and quality by at least two independent reviewers, studies with acceptable risk of bias were included and summary data was extracted from the publications. Main outcomes were mortality, morbidity (including health care utilization) and cost measures. Syntheses without metanalyses were performed due to considerable study heterogeneity. The certainty of the summarized result was assessed using GRADE (the Grading of Recommendations Assessment, Development and Evaluation). PROSPERO study registration number: CRD42020196518.

Findings We identified 2824 unique references and included 15 studies (14 observational and 1 randomized controlled trial) in the review, from which results were derived for six outcomes. For persons with asthma or COPD we found that higher compared to lower relational continuity of care prevents premature mortality (low certainty; 2 studies, 111 545 participants), lowers risk of emergency department visits (low certainty, 5 studies, 362 305 participates) and risk of hospitalization (moderate certainty, 9 studies, 525 716 participants), and lowers health care costs (low certainty; 4 studies, 390 682 participants). Results regarding treatment adherence (1 study, 971 participants) and patient perceptions (3 studies, 2026 participants) were assessed as having very low certainty.

Interpretation Low to moderate certainty evidence suggests that higher versus lower relational continuity of care for persons with asthma or COPD prevents premature mortality, lowers risks of unplanned health care utilization and reduces health care costs. The results may be of value when planning care for individuals and for policymakers in organizing health care and developing guidelines for treatment and follow-up routines.

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Research in context

Evidence before this study

Prior the study start we performed test literature searches in several databases, the latest in MEDLINE on March 25, 2020, using the search terms "chronic obstructive", "lung" or "pulmonary disease" or "asthma", and "continuity of patient care" or "continuity of care". The results indicated that there were published primary studies about the topic, but that existing systematic reviews had addressed management rather than relational continuity and, furthermore, focused on mortality only.

Added value of this study

To the authors' best knowledge this is the first systematic review addressing the effects of relational continuity of care in persons with asthma and/or COPD. Low to moderate certainty evidence suggests that higher versus lower relational continuity of care for persons with asthma or COPD prevents premature mortality, lowers risks of unplanned health care utilization and reduces health care costs. The results may be of value for health professionals when planning care for individuals, and for policymakers in organizing health care, estimating possible reductions in hospitalization and emergency department costs, and developing guidelines for treatment and follow-up routines.

Implications of all the available evidence

Since this is the first systematic review addressing the effects of relational continuity of care in these populations, it can form a basis for care planning, organization and guideline development in this field.

Introduction

Asthma and chronic pulmonary disease (COPD) are among the leading causes of morbidity and mortality in the world[1], contributing to high direct costs for health service utilization and drug use as well as indirect costs due to reduced productivity.[2] While these noncommunicable diseases are chronic and not curable, continuous monitoring and management may facilitate optimal control of symptoms, prevent deterioration and unnecessary health care utilization, ultimately having positive effects on patients' quality of life.

Research around continuity of care tends to distinguish between three types of continuity: *informational continuity* —the use of information of past events and personal circumstances to inform current care; *management continuity* —the consistent and coherent approach within the health care system to manage a health condition that is responsive to a patient's changing needs, and *relational continuity* which focuses on the ongoing relationship between a patient and one or more health care providers.[3,4] A review of the different ways to measure longitudinal and relational continuity of care revealed a diversity of indices which could be classified into having a primary focus on either duration, density of visits, dispersion of providers, sequence of providers or subjective measurements.[5] Relational continuity, as in meeting the same physician or other care provider over time, may facilitate mutual understanding of the condition and the individual's changing needs, which could improve quality of care as well as reduce the need of emergency care. Thus, it was hypothesized that relational continuity would be positively associated with favorable health outcomes and reduced need of unplanned health care utilization.

The aim of this systematic review was to investigate treatment outcomes, including effects on resource use and costs, associated with receiving higher relational continuity of care for patients with asthma or COPD.

Methods

This systematic review was conducted at the Swedish Agency for Health Technology Assessment and Assessment of Social Services, SBU, adhering to the PRISMA reporting guidelines and following a protocol pre-registered on PROSPERO (CRD42020196518). Results of the other study population mentioned in the protocol will be reported separately. Due to considerable heterogeneity in included studies it was not possible to conduct meta-analyses. Thus, syntheses without meta-analysis were used to summarize outcomes associated with receiving higher relational continuity of care for patients with asthma or COPD. The certainty of the evidence was assessed using the GRADE-framework.[6]

Research question and selection criteria

The research question and the inclusion criteria were formulated using the PICO/PECO structure. The population had to have a diagnosis of asthma or COPD and be at least 18 years of age. If the study population was mixed, results were included if they were specified for relevant age groups as well as for asthma and/or COPD populations, or if most participants had a relevant condition.

The exposure had to be relevant to relational continuity of care in that it used a continuity index or measure of duration, density, dispersion, sequencing, fragmentation, or discontinuation of regular care to either a specified person or a team of health care professionals. The exposure should have been present for at least 12 months. Intervention studies were required to alter a dimension of continuity of care, but were not allowed to involve other components, such as enhanced care, education, support groups, etc. Consensus in the project group was used to determine if the intervention fulfilled

these criteria and the follow-up time was sufficiently long to address the research question.

The main outcomes were mortality, morbidity (symptoms and functioning) and health care utilization (emergency department visits, hospitalizations). Additional outcomes were adherence to prescribed medical treatment, relevant laboratory measures and subjective measures such as patient satisfaction and quality of life.

Controlled studies and observational studies (cohort and register studies) were included. Studies that identified themselves as cross-sectional were included if the continuity exposure preceded the measurement or occurrence of the outcome, for example in retrospective register data.

Literature search

A search strategy was developed, tested and further developed by an information specialist with the assistance of researchers in the project group. Blocks of search terms about the populations and the exposure 'continuity of patient care' were used in subject headings and in titles and abstracts. Literature searches were performed between January 1, 2000, and February 1-4, 2021, by the information specialist in the following databases: CINAHL, Medline, PsycINFO, Scopus, Embase, Cochrane Library, Database of Systematic Review of Effects, DARE, Epistemonikos, NICE Evidence Search, KSR Evidence and AHRQ. The search was performed in May to June 2020 and was updated in early February 2021. The searches were complemented with literature identified from reference lists of published literature. Grey literature, books and conference abstracts were not considered. The full search strategy is provided in Supplement 1.

Screening and assessment of relevance

Screening of titles and abstracts to determine if they fulfilled the inclusion criteria was performed independently by two researchers (PL, JB) using the Covidence platform (covidence.org). Disagreements were resolved through discussion in the larger research group and, if questions remained, studies were included to be read in full length. Two researchers with expert knowledge in the field (SE, ME) then independently read all included articles in full length to determine their relevance in terms of the set inclusion criteria. Disagreements were discussed in the larger research group. If there was any ambiguity about the relevance of the exposure, for example whether the measure of continuity was relating to a person or a clinic, the project group decided to include the article in order not to lose too much information and the implications of the indirectness were handled when rating the quality of the evidence.

Quality assessment

The quality of randomized controlled trials was assessed using the RoB2 instrument (version 2 of the Cochrane risk-of-bias tool for randomized trials). For observational studies an instrument was developed based on a preliminary tool for assessing risk of bias of exposure studies, ROBINS-E, and other risk of bias assessment tools used at the Swedish Agency for Health Technology Assessment and Assessment of Social Services. The instrument covered different domains that may affect risk of bias: confounding, exposure, attrition, measurement and analysis of outcomes, reporting, and conflict of interests. It has a similar approach as the ROBINS-I tool, developed for assessing risk of bias in non-randomized studies of interventions.[7] It specifically addresses concerns of bias due to confounding and selection, and aims at assessing risk of bias compared to a prefect hypothetical target trial, thus providing assessments on a scale comparable to those addressed in randomized trials. Overall risk of bias was classified as low, moderate, high or unacceptable. Articles considered to have unacceptable risk of bias for a given outcome were excluded from further analysis. A translated version of the instrument used to assess risk of bias in observational studies is available in Supplement 2.

Data analysis, synthesis and rating of the certainty of evidence

Data was extracted by one researcher and checked for correctness by three others. Data extracted included study type, country where the study was performed, type of study population, participants' age and sex, measurement of exposure, type of analysis, handling of confounders and main results/summary statistics for the outcomes.

Due to substantial heterogeneity in the way the exposure had been measured, categorized and analyzed it was not possible to perform meta-analyses. Instead, results from studies about the main and additional outcomes were synthesized without meta-analysis, where the overall result for each category of outcome was formulated as a summarizing result regarding effect. The GRADE framework was used to rate the certainty of evidence for each statement as high, moderate, low or very low.[8] Five domains were considered: risk of bias, inconsistency of results, indirectness, imprecision and publication bias. Studies with high risk of bias were included so as not to lose information in an area with potentially few studies per outcome. Instead, study quality and any indirectness of the continuity measure were taken into consideration when rating the certainty of the evidence. As we included studies with both randomized and non-randomized design and used a risk of bias tool for non-randomized studies, which addresses consequences of selection and confounding as an integrated part of the

tool, the initial GRADE certainty rating started at high certainty, as suggested by the GRADE working group.[9] Generally, studies using observational data for causal analysis were considered having at least moderate risk of bias, due to a potential risk of residual confounding.

The project group strived to derive precise statements with lower certainty rather than the other way around, as more precise statements were considered to be of higher value for health care professionals and decision makers.

Role of the funding source

There was no funding source for this study. All authors had access to the included studies and the extracted data. All approved on the decision to submit and gave one person (PL) final responsibility to do so.

Results

We identified 2824 unique references, of which 36 articles were read in full text. Sixteen articles fulfilled the inclusion criteria,[10-25] of which one[25] was later excluded because of an unacceptable risk of bias. Of the 15 included articles, 14 were based on observational data, mainly retrospective cohort studies, and one[24] was a randomized controlled study. Two articles[17,18] presented analyses on almost the same study population but for different outcomes. Of the 15 included articles none were deemed to have low risk of bias, twelve had moderate and three high risk of bias. The identification, selection and outcome of risk of bias assessments of included studies is shown in Figure 1 (PRISMA flow chart of searched and included studies) and the risk of bias assessments and reasons for exclusion of non-included studies are shown in Supplement 3 and 4, respectively. A summary of characteristics of the included studies is shown in Table 1.

The studies were mainly performed in Asia (Korea or Taiwan), Europe or the United States and reported results from analyses based on more than 500 000 participants with either asthma or COPD. There was considerable heterogeneity among studies in the way continuity had been measured and operationalized in the analyses, as well as in the choice of statistical modelling. The reported outcomes allowed categorization into the following summarized outcomes: mortality (two studies), emergency department (ED) visits (five studies), hospitalizations (nine studies), costs (four studies), adherence to treatment (one study) and a composite measurement of health care experience, knowledge of self-management and health-related quality of life (three studies). No results were found reporting outcomes on laboratory measures.

Below are the results for the different outcomes and a brief description of the studies included in each outcome category. Table 2 provides a summary of the results and evidence gradings. Supplement 5 provides effects in asthma and COPD subgroups, respectively, and more information about the reasons for reductions in the certainty of the evidence. Supplement 6 provides detailed informational about the included studies.

Mortality

Two studies investigated the association between relational continuity of care and mortality in altogether 111 425 persons with either asthma or COPD. Cho et al reported a median survival for those with a low COC index score of 2·92 years compared to 4·00 years for those with a high COC-index score (p<0·0001). The adjusted hazard ratio for low versus high COC was 1·22 (95% CI 1·09 to 1·36).[10] The study by Einarsdottir et al compared different quintiles of a regularity-index score, where all four analyses showed a consistent trend of reduced hazard ratios for those with higher compared to lower regularity; however, only one analysis gave statistically significant results.[12]

The overall result for the outcome mortality was: *"Higher relational continuity of care for persons with asthma or COPD prevents premature mortality"*. The certainty of the evidence was considered to be low for the population asthma/COPD and COPD separately, and very low for asthma alone.

Hospitalization

Nine studies with a total of 525 716 participants investigated the effect of relational continuity of care on risk of future hospitalization.[12-16,18,19,21,22] The definition of hospitalization varied somewhat, but typically concerned hospitalization, re-hospitalization or condition-specific hospitalization. The analytic approaches also varied, where some studies compared lower to higher continuity while others did the opposite. All results were, however, consistent in showing favorable outcomes for those with higher continuity of care, with the exception of one study with a non-statistically finding in one subpopulation.[22]

The overall result on the outcome hospitalization was: "Higher relational continuity of care for persons with asthma or COPD lowers risk of hospitalization by a moderate to high degree". The certainty of the evidence was considered to be moderate for the population asthma/COPD and COPD separately, and low for the asthma population.

Emergency department visits

Five studies with a total of 362 305 participants investigated the effect of relational continuity of care on the risk of future ED-visits.[14-17,21] Two studies had overlapping populations.[16,17] All studies used various categorizations of the COC index in multiple logistic regressions or proportional hazard models.

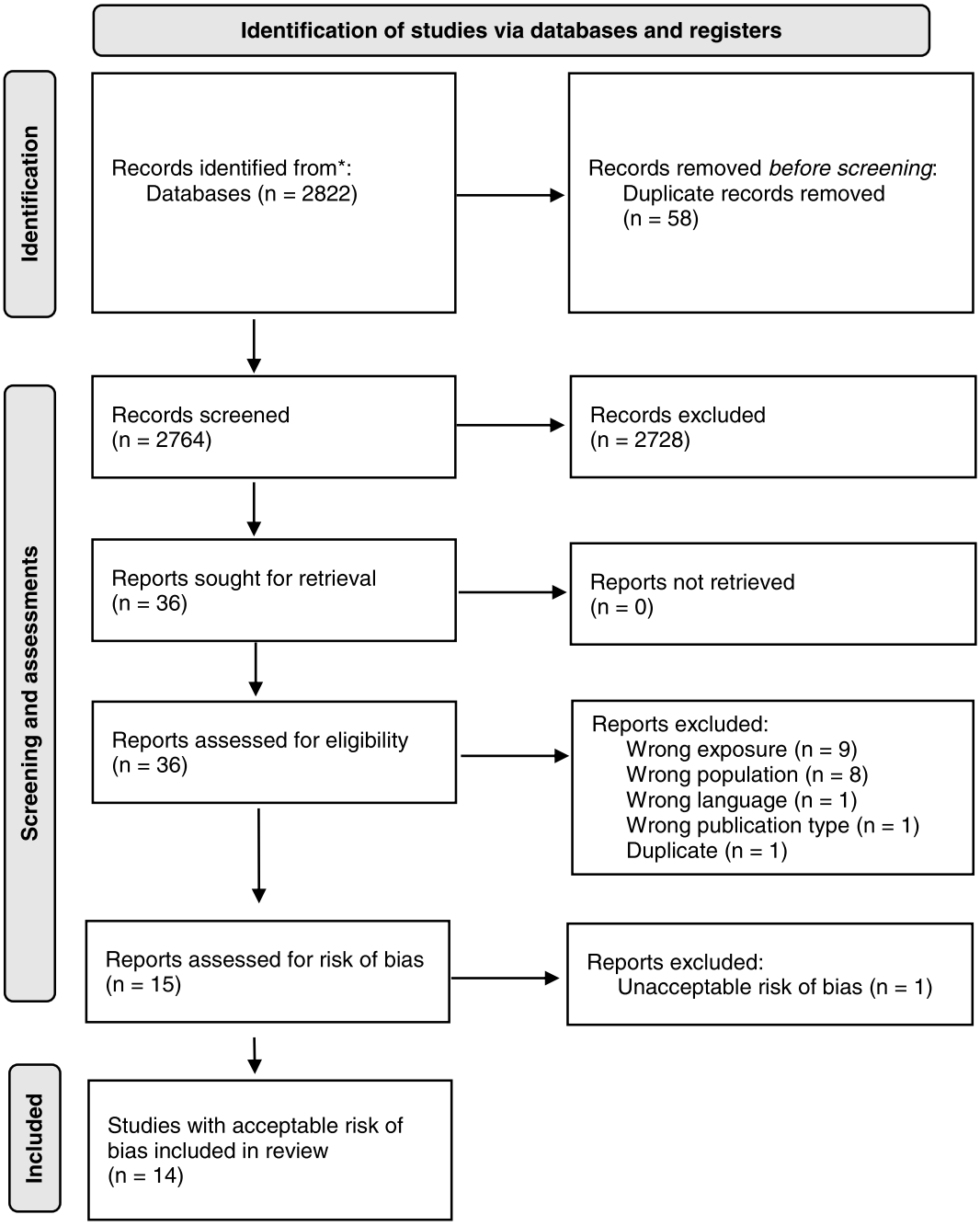

Figure 1. PRISMA flow chart of searched and included studies.

All results suggested an association between having higher continuity of care and lower risk of future ED-visits. The overall result on the outcome ED-visits was formulated as: "*Higher relational continuity of care for persons with asthma or COPD lowers risk of ED-visits by a moderate to high degree*". The certainty of the evidence was assessed as low for the population asthma/COPD, as well as for asthma and COPD separately.

Health care costs

Four studies covering a total of 390 685 individuals investigated the effect of relational continuity of care on health care costs.[13-15,21] There were uncertainties about what costs were included, how they were calculated and how the results were presented, for example as relative or absolute differences and for different categorizations of continuity. However, all four studies were consistent

Author Year	Study type Country/region Data period	Population N Age	Measure of exposure (continuity)	Outcome(s) Type(s) of analysis	Reported results	Overall risk of bias	Comment
Cho et al. 2015	Retrospective cohort South Korea Data period: 2002-2012	COPD n=3090 Mean age 69.0 years	CoC index, dichotomized in analysis	All-cause mortality Cox regression	Low versus high COC: HR 1.22 (95% CI 1.09 to 1.36).	Moderate	Continuity measure based on medical institution rather than individual physician. COC included as time-dependent covariate in analysis.
Corsico et al. 2007	Cross sectional survey Mainly European countries Data periods 1990—1994 and 1998—2002, mean length of follow up 8.1 years	Asthma n=971 Mean age at first survey 34.0 years	Regular appointments with doctor or nurse	Adherence to prescribed anti-asthmatic treatment Logistic regression	Having regular appointments and *increased* adherence: OR 3.32 (95% CI 1.08 to 10.17). Having regular appointments and *persistent* adherence: OR 1.23 (95% CI 0.55 to 2.75).	High	Self-reported data for exposure and outcome variables.
Einarsdottir et al. 2010	Retrospective cohort Australia Data period 1992—2006	Chronic respiratory disease (asthma, COPD, Emphysema, chronic bronchitis) n=108 455 Mean age 72.7 years	General practitioner regularity score (0-1), comparison of quintiles in analyses	All-cause mortality. First CRD hospitalization Cox regression	All-cause mortality for least regular continuity quintile compared to: 2nd least regular: HR 0.90 (95% CI 0.79 to 1.01) Medium regular: HR 0.84 (95% CI 0.75 to 0.95) 2nd most regular: HR 0.90 (95% CI 0.80 to 1.01) Most regular: HR 0.95 (95% CI 0.83 to 1.08) First CRD hospitalization for least regular continuity quintile compared to: 2nd least regular: HR 0.92 (95% CI 0.83 to 1.00) Medium regular: HR 0.84 (95% CI 0.77 to 0.92) 2nd most regular: HR 0.74 (95% 0.67 to 0.82) Most regular: HR 0.77 (95% CI 0.68 to 0.86)	Moderate	

Table 1 *(Continued)*

Author Year	Study type Country/region Data period	Population N Age	Measure of exposure (continuity)	Outcome(s) Type(s) of analysis	Reported results	Overall risk of bias	Comment
Frandsen et al. 2015	Retrospective cohort study US Data period 2004—2008	COPD n=32 916 Mean age 46.3 years	Care fragmentation index	Hospitalisations of ambulatory care-sensitive conditions Medicare costs Linear regression	Regression coefficients for 1 SD change in fragmentation in COPD subgroup: Any ACSC hospitalizations: 25% least fragmented vs. 29% most fragmented. Costs: USD 12 702 least fragmented vs. USD 19 368 most fragmented.	High	Possible overlap between components of exposure measure and resources included in cost calculations.
Hong et al. 2010	Retrospective cohort study South Korea Data period 2002—2006	Asthma n=129 550 Mean age 72.0 years COPD n=131 512 Mean age 72.1 years	Continuity of Care index, comparison of terciles in analyses	Hospitalization Emergency department visits/ Logistic regression Healthcare costs/ Linear regression	Asthma, hospitalization: low vs. high COC, OR: 2.07 (95% CI 1.92 to 2.23) medium vs. high COC, OR 1.56 (95% CI 1.45 to 1.68) Asthma, ED visits: low vs. high COC, OR: 2.25 (95 % CI 1.87 to 2.70) medium vs. high COC, OR: 1.38 (95 % CI 1.14 to 1.67). Asthma, healthcare costs: low vs. high COC, regression coefficient: 0.025 (p<0.001) medium vs. high COC, regression coefficient: 0.022 (p=0.001). COPD, hospitalization: low vs. high COC, OR: 1.99 (95% CI 1.86 to 2.13) medium vs. high COC, OR: 1.50 (95% CI 1.41 to 1.61). COPD, ED visits: low vs. high COC, OR: 1.77 (95% CI 1.45—2.17) medium vs. high COC, OR: 1.30 (95% CI 1.06 to 1.59). COPD, costs: low vs. high COC, regression coefficient: 0.123 (p<0.001) medium vs. high COC, regression coefficient: 0.077 (p<0.001).	Moderate	Continuity measure based on medical institution rather than individual physician. Possible overlap between components of exposure measure and resources included in cost calculations.

Table 1 (Continued)

Author Year	Study type Country/region Data period	Population N Age	Measure of exposure (continuity)	Outcome(s) Type(s) of analysis	Reported results	Overall risk of bias	Comment
Hussey et al. 2014	Retrospective cohort study US Data period 2008—2009	COPD n=76 520 Age ≥65 years	Continuity of Care index, assessed as deciles in analyses	Hospitalizations Emergency department visits Logistic regression Costs of care per episode Linear regression	Hospitalization per 0.1 unit increase in COC index: OR 0.95 (95% CI 0.94—0.96). ED visits per 0.1 unit increase in COC index: OR 0.93 (95% CI 0.92—0.93). Total episode costs per 0.1 increase in COC index: 6.3% lower costs.	Moderate	Cross-sectional analysis with unclear measurement period for exposure. Possible overlap between components of exposure measure and resources included in cost calculations.
Kao et al. 2016 and 2017	Retrospective cohort study Taiwan Data period 2004—2013	Kao 2016: Asthma n= 3356 Age ≥65 years Kao 2017: Asthma 3356 Age ≥65 years	Continuity of Care index. Kao 2016: divided into low (<0.5), medium (0.5—0.99) and high (1). Kao 2017: divided into low (<0.47), medium (0.48—0.99) and high (1).	Kao 2016: Avoidable hospitalizations. Kao 2017: Emergency department visits. Cox regression	Avoidable hospitalizations, low vs. high COC: HR 2.68 (95% CI 1.55 to 4.63) moderate vs. high COC: HR 1.49 (95% CI 0.80 to 2.75) ED visits, low vs. high COC: HR 2.11 (95% CI 1.37 to 3.25) moderate vs. high COC: HR 1.15 (95% CI 0.70 to 1.87).	Moderate	Two articles based on same study reporting two different outcomes, however, without any reference to the other.
Kao et al. 2019	Retrospective cohort study Taiwan Data period 2004—2013	Asthma-COPD overlap n=1141 Mean age 74.4 years	Continuity of Care index. Divided into low (0—0.29), medium (0.3—0.99), high (1).	ED visits. Hospitalizations for COPD or asthma. Cox regression	ED visits, low vs. high COC: HR 2.80 (95% CI 1.45 to 5.38), moderate vs. high, COC: HR 2.69 (95% CI 1.47 to 4.93). Hospitalizations, low vs. high COC: HR 1.80 (95% CI 1.03 to 3.13), moderate vs. high COC: HR 1.72 (95% CI 1.04 to 2.83).	Moderate	Based on same database extraction as Kao 2016 and Kao 2017.

Table 1 *(Continued)*

Author Year	Study type Country/region Data period	Population N Age	Measure of exposure (continuity)	Outcome(s) Type(s) of analysis	Reported results	Overall risk of bias	Comment
Lin et al. 2017	Retrospective cohort study Taiwan Data period 2005—2009	COPD n=2199 Age ≥40 years	Continuity of Care index over 2 time periods: short term (1 year and long term (2 years) divided into terciles in analyses.	COPD-related hospitalisation. Logistic regression.	Short-term COC: low vs. high COC: OR 1.59 (95% CI 0.91 to 2.76) medium vs. high COC: OR 1.89 (95% CI 1.07 to 3.33), Long-term COC: low vs. high COC: OR: 1.98 (95% CI 1.00 to 3.94) medium vs. high COC: OR: 2.03 (95% CI 1.05 to 3.94).	Moderate	Article by Lin et al. published in 2015 used same cohort, but included patients who died during first two years of observation period (total n=3015); analysis was only for long-term COC.
Love et al. 2000	Cross sectional survey with 12 months recall US Data period 1997	Asthma n=404 Mean age 49.3 years	Patient perception of continuity, assessed on 4-item scale	Patient assessment of care as provider communication and patient influence Linear regression.	Continuity of care significant (p=0.01) in predicting perception of provider communication, coefficient 0.147. Continuity of care significant (p=0.02) in predicting perception of patient influence, coefficient 0.144.	High	Self-reported data. Outcomes do not directly measure patient satisfaction.

Table 1 *(Continued)*

Author Year	Study type Country/region Data period	Population N Age	Measure of exposure (continuity)	Outcome(s) Type(s) of analysis	Reported results	Overall risk of bias	Comment
Svereus et al. 2017	Retrospective cohort study Sweden Data period 2012—2013	COPD n=20187 Age ≥ 55 years	CoC index, comparison of quintiles in analyses	Hospitalisation Emergency department visits Logistic regression Cost for healthcare and pharmaceuticals Linear regression	Lowest compared to highest COC quintile: Any hospitalization: OR 2.17 (95% CI 1.95—2.43). Any emergency department visit: OR 2.06 (95% CI 1.86—2.28). Relative increase in costs: 58 % (52—64 %). Second lowest compared to highest COC quintile: Any hospitalization: OR 1.68 (95% CI 1.50—1.87). Any emergency department visit: OR 1.66 (95% CI 1.50—1.84). Relative increase in costs: 41 % (35—46 %). Third lowest compared to highest COC quintile: Any hospitalization: OR 1.57 (95% CI 1.41—1.75). Any emergency department visit: OR 1.68 (95% CI 1.52—1.86). Relative increase in costs: 32 % (27—37 %). Fourth lowest compared to highest COC quintile: Any hospitalization: OR 1.40 (95% CI 1.28—1.56). Any emergency department visit: OR 1.41 (95% 1.28—1.56). Relative increase in costs: 21 % (17—26 %).	Moderate	Definition of continuity on clinic-level. Concurrent measurement of exposure and outcomes does not allow conclusions about causality. Possible overlap between components of exposure measure and resources included in cost calculations.

Table 1 *(Continued)*

Author Year	Study type Country/region Data period	Population N Age	Measure of exposure (continuity)	Outcome(s) Type(s) of analysis	Reported results	Overall risk of bias	Comment
Swanson et al. 2018	Retrospective cohort study Germany, Norway Data period 2009—14	COPD Germany: n=6373 Mean age: 73.3 years Norway: n=13507 Mean age: 71.8 years	Three different continuity of care indices: CoC index, UPC index and SECON index, all used as deciles in analyses	Readmission within 30 days and 1 year. Logistic regression. Negative binominal regression.	Germany: OR for 30-day readmission: COCI 0.990 (95% CI 0.960—1.021) UPC 0.993 (95 % CI 0.955—1.032) SECON 0.987 (95 % CI 0.956—1.018) Incidence rate ratio for 1-year readmission: COCI 1.002 (95% CI 0.987—1.017) UPC 1.003 (95 % CI 0.985—1.021) SECON 1.003 (95 % CI 0.989—1.018) Norway: OR for 30-day readmission: COCI 0.987 (95% CI 0.967—1.008) UPC 0.986 (95 % CI 0.962—1.010) SECON 0.987 (95% CI 0.970—0.990) Incidence rate ratio for 1-year readmission: COCI 0.967 (95% CI 0.956—0.978) UPC 0.961 (95% CI 0.948—0.974) SECON 0.962 (95% CI 0.952—0.973)	Moderate	
Wireklint et al. 2020	Cross-sectional cohort study Sweden 2012 and 2015	Asthma n=1442 Largest age group 40—59 years (41 %)	Physician continuity (assignment to a patient-specific physician)	Patient-reported knowledge of self-management of worsening asthma (defined as exacerbations or deteriorations) Logistic regression	OR of having sufficient knowledge of management of asthma exacerbations. Physician continuity vs. not: OR 2.19 (95 % CI 1.62—2.96).	Moderate	Self-reported data.

Table 1 *(Continued)*

Author Year	Study type Country/region Data period	Population N Age	Measure of exposure (continuity)	Outcome(s) Type(s) of analysis	Reported results	Overall risk of bias	Comment
Uijen et al. 2012	Randomized controlled trial The Netherlands Data period 2004—2006	COPD n=180 Mean age 64.5 years	3 modes of care administration in primary care, of which one was regular monitoring as adjunct to usual care	Health Related Quality of Life measured with self-administered Chronic Respiratory Questionnaire. Pearson's correlation coefficient of continuity of care and change in CRQ between baseline and mean of 18- and 24-month measurements.	No clinically relevant difference in CRQ score (>0.5) was seen for different UPC scores. Pearson's correlation coefficient of difference in CRQ and personal continuity: 0.117. Pearson's correlation coefficient of difference in CRQ and team continuity: -0.041.	Moderate	Self-reported data of exposure and outcome.

Table 1: **Summary of study characteristics and results of included studies.**

Notes:
ACSC = ambulatory care-sensitive condition; CI = confidence interval; COPD = Chronic obstructive pulmonary disease; COC = Continuity of Care; COCI = Continuity of Care Index by Bice & Boxerman; CRD = chronic respiratory disease; CRQ = Chronic Respiratory Questionnaire; ED = emergency department; HR = hazard ratio; OR = odds ratio; SECON = Sequential Continuity Index; UPC = Usual Provider Continuity; USD = US dollar

in the finding that higher continuity of care was associated with lower health care costs. The overall result[24] was formulated as: "*Higher relational continuity of care for persons with asthma or COPD lowers health care costs*". The certainty of the evidence was considered to be low for the population asthma/COPD, as well as for asthma and COPD separately.

Experience of participation in care and self-management of disease

Three studies investigated various patient assessments of experience of received care, self-management of disease and quality of life.[20,23,24] The assessment of continuity of care was only partially relevant and the results were presented in various ways. All results were, however, consistent in their findings that higher relational continuity of care showed a positive association with experience, communication and participation[20], self-management of the disease[23] and health-related quality of life.[24]

The overall result was formulated as: "Higher relational continuity of care for persons with asthma or COPD may improve patients' experience of participation and knowledge about self-management of the disease." The certainty of the evidence was considered to be very low for the population asthma/COPD, and the COPD and asthma populations separately.

Adherence to pharmacotherapy

One study with 971 participants investigated the effect of relational continuity of care on pharmacological treatment adherence.[11] The study was considered to have a high risk of bias, the overall certainty of the evidence was assessed as very low and, consequently, no result statement was formulated.

Discussion

The results in this systematic review suggest that higher relational continuity of care for persons with asthma and/or COPD prevents premature deaths, lowers the risks of ED-visits and hospitalizations and lowers health care costs compared to those receiving lower levels of relational continuity of care. The certainty of the evidence was moderate for the effect on hospitalization and low for the effects on mortality, ED-visits and health care costs. The certainty of the results about adherence and experience of participation in care and self-management of the disease were very low.

To the authors' best knowledge this is the first systematic review addressing the effects of relational continuity of care in persons with asthma and/or COPD. Previously, Yang et al. performed a systematic review of the effect of different continuity of care interventions on readmission and mortality.[26] The included studies

Outcome	Number of studies/ participants (N)	Summarized result	Certainty of evidence according to GRADE	Reasons for reduced certainty of the evidence
Mortality	2 N=111 545	Higher relational continuity of care for persons with asthma or COPD prevents premature mortality.	Low	Risk of bias − 1 Indirectness − 0.5 Imprecision − 0.5
Hospitalization	9 N=525 716	Higher relational continuity of care for persons with asthma or COPD lowers risk of hospitalization by a moderate to high degree.	Moderate	Risk of bias − 1
Emergency department visits	5 N=362 305	Higher relational continuity of care for persons with asthma or COPD lowers risk of hospitalization by a moderate to high degree.	Low	Risk of bias − 1 Indirectness − 1
Costs	4 N=390 685	Higher relational continuity of care for persons with asthma or COPD lowers health care costs.	Low	Risk of bias − 1 Imprecision − 1
Experience of participation in care and self-management of disease	3 N=2026	Higher relational continuity of care for persons with asthma or COPD may improve patients' experience of participation and knowledge about self-management of the disease.	Very low	Risk of bias − 1 Indirectness − 2 Imprecision − 0.5
Treatment adherence	1 N=971	It is not possible to assess the effects of relational continuity of care for persons with asthma or COPD on adherence to pharmacotherapy due to the very low certainty of the evidence	Very low	Risk of bias − 2 Indirectness − 1 Imprecision − 0.5

***Table 2:* Summarized results and evidence ratings for the combined populations asthma or COPD.**

investigated various types of interventions, such as comprehensive care, health education and telemonitoring. Thus, they addressed management continuity rather than relational continuity. Their results implied that there was some evidence of reduced readmissions over different time frames, but there were no statistically significant findings on mortality.

The present study has some important limitations. The literature search was restricted to studies published in English from the year 2000 and onward in peer review journals. This means that relevant studies published before this, in other languages or as grey literature, might have been overlooked. All included studies, except one, were of non-randomized design, which implies an increased risk of bias due to confounding. Confounders of special concern are severity of the condition and co-morbidity, which both may affect the need for continuity of care as well as many of the outcomes studied. Most studies adjusted for one or more factors related to these issues, but residual confounding cannot be ruled out. However, if such residual confounding exists, its force would be to lower the effect results, i.e., weaken the associations. When it comes to the outcome of health care costs, a methodological challenge lies in the inclusion of outpatient visits both as part of the exposure measurement (in the form of a continuity index) and as part of the outcome. This leads to increased uncertainty around the resulting association for this particular outcome.

Publication bias was not considered to be a major problem in this research field. Most studies did not provide a study protocol or analysis plan, making the data selection time frame and the analytic approach susceptible to selection bias. There was much heterogeneity in the analytic approaches used, e.g., how measures of continuity were operationalized, analyzed and presented, making it difficult to compare results and impossible to summarize them in meta-analyses. However, the overall results were consistent in their direction, in that higher compared to lower continuity of care seems to be favorable across the range of different outcomes. This strengthens our belief in the results.

Given the heterogeneity in methods, suggestions for future research include the development and establishment of precise terms and measures for how to conduct research around continuity of care. Specific areas of interest relate to appropriate study designs, analytical methods and strategies for addressing confounding. As most published research is based on observational studies, future studies using an experimental design could provide an important complement to the existing evidence base. This kind of experimental research could aid in confirming observed effects and in studying the mechanisms underlying relational continuity of care.

In summary, this systematic review provides low to moderate certainty evidence that higher relational continuity of care for persons with asthma or COPD prevents

premature mortality, lowers risks of unplanned health care utilization and lowers health care costs. These results may be of value for health professionals planning treatment and care for patients with asthma or COPD. The results can be used by policymakers for estimating possible reductions in hospitalizations and emergency department costs with increased relational continuity, for assessing different ways of organizing health care, and for developing guidelines of treatment and follow-up routines.

Contributors

PL JB JL MKE SE ME IE LH LA planned the study. MKE performed literature searches. PL and JB screened abstracts, PL JB SE ME IE LH and LA performed assessments of relevance and risk of bias in pairs, independently. PL JB extracted data, which was verified by SE and ME. PL JB MKE SE ME IE LH LA performed synthesis and evidence GRADINGs of results. PL wrote the first draft of the report with initial support from JB. All authors read and contributed to the final draft manuscript. All authors had access to all data/ assessed studies, and all agreed to the decision to submit.

Declaration of interests

All authors declare no competing interests.

Data sharing statement

All available data is provided in the manuscript.

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Supplementary materials

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