



Development of an instrument to measure perceived gentrification for health research: Perceptions about changes in environments and residents (PACER)

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ABSTRACT

Despite a myriad of potential pathways linking neighborhood change and gentrification to health, existing quantitative measures failed to capture individual-level, self-reported perceptions of these processes. We developed the Perceptions About Change in Environment and Residents (PACER) survey to measure the gentrification-related neighborhood change experienced by individuals relevant to health. We employed a multi-stage process to develop PACER including a scoping review, question refinement, content validity, and cognitive interviews. Content validity and cognitive interviews were assessed within the National Neighborhood Indicators Partnership (NNIP) and for residents of different tenure in both gentrifying and non-gentrifying neighborhoods to ensure PACER considers the complex nature of neighborhood change for different people within different urban contexts. We piloted the instrument to a sample from the resident panel BeHeardPhilly to assess acceptability and data quality. Finally, we assessed internal consistency, dimensionality, and criterion-related validity using Principal Components Analysis (PCA), descriptive statistics, and correlation coefficients. Testing showed good internal consistency for PACER questions, as well as for each of four resulting factors (Feelings, Built Environment, Social Environment, and Affordability). Correlations between factors and other context measures demonstrated strong criterion-related validity. PACER offers an unprecedented tool for measuring and understanding resident perceptions about gentrification-related neighborhood change relevant to health. Rigorously tested and tailored for health, PACER holds utility for application across different settings to examine changes from events that may impact and shift neighborhoods.

1. Introduction

1.1. Neighborhood change and health

Neighborhood context is important for health, independent of individual-level behaviors and attributes, leading to variations in quality of life, health, and mortality across communities (Diez Roux, 2001; Duncan & Kawachi, 2018; Meijer, Röhl, Bloomfield, & Grittner, 2012; Sampson, 2003). A range of potential pathways linking neighborhood environments to health behaviors and outcomes have been identified. Supportive social environments were associated with increased social

connectedness (Lenzi, Vieno, Santinello, & Perkins, 2013; Yen, Shim, Martinez, & Barker, 2012), decreased stress (Echeverría, Diez-Roux, Shea, Borrell, & Jackson, 2008; Henderson, Child, Moore, Moore, & Kaczynski, 2016; Johns et al., 2012), and improved mental health outcomes (Barnett, Zhang, Johnston, & Cerin, 2018; Cramm, Van Dijk, & Nieboer, 2013; Farrell, Aubry, & Coulombe, 2004; Kubzansky et al., 2005; Christina, Mair, Roux, & Galea, 2008; Miles, Coutts, & Mohamadi, 2012; Stafford, McMunn, & De Vogli, 2011). Evidence also suggests that certain built environment characteristics supported increased physical activity (Hirsch et al., 2014; Hirsch, Moore, Evenson, Rodriguez, & Roux, 2013; Ranchod, Diez Roux, Evenson, Sánchez, & Moore, 2014),

Abbreviations: BHP, BeHeardPhilly Municipal Panel; ISR, Institute for Survey Research; NNIP, National Neighborhood Indicators Project; NCGS, Neighborhood Change and Gentrification Scale; PANJAAPOR, Pennsylvania and New Jersey American Association for Public Opinion Research; PACER, Perceptions About Change in Environment and Residents; PCA, Principal Components Analysis.

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decreased risk of diabetes or cardiovascular disease (Amuda & Berko-witz, 2019; Den Braver et al., 2018; Diez; Christine et al., 2015; Den; Malambo, Kengne, De Villiers, Lambert, & Puoane, 2016; Pasala, Rao, & Sridhar, 2010; Diez Roux, Mujahid, Hirsch, Moore, & Moore, 2016), and other chronic diseases (Fitzpatrick & Willis, 2020; Jackson, Dannenberg, & Frumkin, 2013; Rachele et al., 2019; Rosso, Auchincloss, & Michael, 2011). Within U.S. cities, inequalities in resource allocation in neighborhoods have been created and reinforced by historic conditions, political or economic orders, legal codes, social and cultural institutions, and ideologies (Jargowsky, 1997; Northridge, Sclar, & Biswas, 2003; A.; Schulz & Northridge, 2004; A. J.; Schulz, Williams, Israel, & Lempert, 2002; Williams & Collins, 2016; Wilson, 2012). For example, federal policies in the early 1900's encouraged mortgage lenders to withhold credit from older urban neighborhoods, immigrant communities and, especially, areas where African-Americans or other people of color lived. Known as redlining, this racist practice resulted in segregated neighborhoods with poorer housing while prohibited neighborhoods had better access to services, parks, highways, and other amenities that contributed to home values for decades (Williams & Collins, 2016).

Neighborhoods are in constant flux from three dynamic and intertwined processes: movement of people, public policies and investments, and flows of private capital (Zuk, Bierbaum, Chapple, Gorska, & Loukaitou-Sideris, 2018). Several longitudinal studies have expanded the neighborhood-health literature to include estimates of the impacts of neighborhood change (Chandrabose et al., 2019; Diez Roux et al., 2016; Kärmeniemi, Lankila, Ikäheimo, Koivumaa-Honkanen, & Korpelainen, 2018; C; Mair et al., 2015; Moore et al., 2016; Tcymbal et al., 2020). Analyses show links between change in neighborhood built environments and physical activity, obesity, and cardiovascular disease (Chandrabose et al., 2019; Diez; Kärmeniemi et al., 2018; Diez Roux et al., 2016; Tcymbal et al., 2020). Similar evidence exists for changes in social environments with mental health, physical health, and health outcomes (C Mair et al., 2015; Moore et al., 2016). Critically missing from the existing literature is a measurement of *experiencing change* and a conceptualization of how these experiences may impact health. For example, physical neighborhood changes might be disorienting for older adults, creating cognitive obstacles to aging within their neighborhoods or accelerating cognitive decline (Oswald, Schilling, Wahl, & Gäng, 2002). Shifting social environments could disrupt social ties or dismantle social cohesion and networks (Betancur, 2011; Hwang & Sampson, 2014; Shmool et al., 2015). The direct impacts of these types of neighborhood changes have not been adequately evaluated (Kerr, Rosenberg, & Frank, 2012).

Gentrification, a specific type of neighborhood change, represents a neighborhood shift from disinvestment to reinvestment with an influx of wealthier, educated residents (Bostic & Martin, 2003; Ding, Hwang, & Divringi, 2016; L.; Freeman, 2005; Lance; Freeman & Braconi, 2004; Hammel & Wyly, 1996; Zuk et al., 2018). A term first used in 1964 to describe the influx of the “gentry” in low income neighborhoods in London (Glass, 1964), today it encompasses improved neighborhood physical conditions, higher costs of housing, demographic shifts or pressures, new economic or recreational opportunities, and social or cultural shifts (Atkinson & Bridge, 2004; Bostic & Martin, 2003; Ding et al., 2016; Freeman, 2005; Freeman & Braconi, 2004; Hammel & Wyly, 1996; Lehrer & Wieditz, 2009; Smith, Breakstone, Dean, & Thorpe, 2020; Zuk et al., 2018). Research examining the health impacts of gentrification is growing (Anguelovski, Connolly, Garcia-Lamarca, Cole, & Pearsall, 2019; Bhavsar, Kumar, & Richman, 2020; Cole, Garcia Lamarca, Connolly, & Anguelovski, 2017; Gibbons & Barton, 2016; Huynh & Maroko, 2014; Izenberg, Mujahid, & Yen, 2018; Schnake-Mahl, Sommers, Subramanian, Waters, & Arcaya, 2020; Schnake-Mahl, Jahn, Subramanian, Waters, & Arcaya, 2020; G. S.; Smith et al., 2020; Tulier, Reid, Mujahid, & Allen, 2019), but research must more consistently incorporate the unevenness of gentrification's impacts (Cole et al., 2017; Dragan, Gould Ellen, & Glied, 2019; Gibbons & Barton, 2016; Huynh & Maroko, 2014), identify the specific mechanisms proposed to

link gentrification to health (Anguelovski et al., 2019; Bhavsar et al., 2020), or consider space and time. However, existing research on gentrification-related neighborhood change and health is constrained by existing measurement tools.

1.2. Measurement of neighborhood change

Often, change is measured quantitatively using repeated cross-sectional assessments (Chandrabose et al., 2019; Diez Roux et al., 2016; Kärmeniemi et al., 2018; C; Mair et al., 2015; Moore et al., 2016; Tcymbal et al., 2020). For specific change processes (i.e. gentrification), while measures of gentrification vary widely, researchers most commonly use quantitative socioeconomic data from census and compare changes in census values relative to similar changes occurring in neighboring census tracts (Bhavsar et al., 2020; Ding et al., 2016; L.; Freeman, 2005; Hammel & Wyly, 1996). These secondary data approaches result in dichotomous or categorical measures of gentrification measuring limited types of changes (i.e. usually only socioeconomic and demographic) at fixed temporal scales (i.e. usually based on decennial census) (Bhavsar et al., 2020). Qualitative interviews and case studies describe shifting neighborhoods and elucidate experiences of change (Doucet, 2009; Hwang & Sampson, 2014; Mirabal, 2009; Murdie & Teixeira, 2011; Shmool et al., 2015; Sullivan, 2006); however, these in-depth approaches limit sample size and generalizability.

Some emergent work has aimed to use surveys measuring gentrification and experiences of gentrification-related neighborhood change (DeVylder, Fedina, & Jun 2019; Dsouza et al., 2021). The first is a set of questions CDC included in the 2018 *SummerStyles/HealthStyles* web-based panel survey (Dsouza et al., 2021). These questions were limited to affordability concerns stemming from new physical activity infrastructure and failed to capture the breadth of changes associated with gentrification that could impact health. The second, the Neighborhood Change and Gentrification Scale (NCGS), is more comprehensive and allows residents to self-report neighborhood disruptions and neighborhood gentrification (DeVylder et al., 2019). The NCGS is a critical development for our ability to measure perceptions of neighborhood change but was not designed for health research. It was not derived from or tailored with a model of gentrification's impacts on health and, therefore, has less focus on the features that are part of the pathways described above. In addition, its development process left out key practices for scale development necessary for application in large public health or epidemiologic studies (i.e. cognitive interviews to pretest questions, input from residents, or conceptualization and validity across multiple cities and contexts). This includes only being developed and tested in two east coast, dense cities of similar age and population composition (New York City, NY and Baltimore, MD).

1.3. The present study

We developed the Perceptions About Change in Environment and Residents (PACER) survey to measure the gentrification-related neighborhood change experienced by individuals relevant to health. The present study articulates the process we employed to develop an instrument to measure perceived gentrification for health research. To enhance current literature, we considered the complex nature of neighborhood change specific to health and incorporated relevant insight for a range of populations within different city and regional contexts.

2. Materials and methods

We conducted a multi-stage process (Table 1) combining a scoping literature review, expert input from both neighborhood and survey experts, cognitive interviews with residents, and a validity and reliability study using members of a municipal survey panel in Philadelphia. We examined acceptability and data quality, internal consistency and

Table 1
Steps, stakeholders, and survey metrics for development and refinement of PACER (Perceptions About Changing Environment and Residents).

	Participants (n)	Purpose for PACER Development
Step 1. Development and refinement of draft measures		
1.1 Scoping review and synthesis of literature and question generation	Urban health researchers (4)	Generates draft questions (n = 86)
1.2 Question refinement	Urban health researchers (2) Survey researchers (2)	Reduces questions for clarity, duplicity, and content (n = 43)
Step 2. Content Validity		
2.1 Online survey	NNIP partners (28)	Reduces questions based on appropriate for national contexts (n = 37)
2.2 Expert Cognitive interviews	NNIP partners (8)	Refines questions using national contexts
Step 3. Pre-testing		
3.1 Workshop	PANJAAPOR members (~25)	Reduces and refine questions based on best practices for opinion research (n = 29)
3.2 Resident Cognitive Interviews	New residents in gentrifying neighborhoods (4) Long-time residents in gentrifying neighborhoods (4) Residents in non-gentrifying neighborhoods (4)	Reduce and refine questions, including wording to improve appropriateness of language and ease of understanding (n = 27)
Step 5. Analyses of Survey Metrics and Performance		
5.1 Survey to resident panel	BeHeardPhilly Panel (212)	Tests acceptability and burden to resident respondents
5.2 Geocoding residents	BeHeardPhilly (211)	Facilitates testing of concurrent validity
5.3 Acceptability and data quality	BeHeardPhilly (211)	Eliminates poor performing questions (n = 25: n = 19 total and n = 6 for context)
5.4 Internal consistency and dimensionality (PCA)	BeHeardPhilly (209)	Identifies subscales (n = 4) and examines internal consistency.
5.5 Criterion-related validity	BeHeardPhilly (209)	Examines relationship between subscales and perceptions of overall change

dimensionality, and criterion-related validity.

2.1. Development and refinement of draft measures

We began with a scoping review to develop a broad view of gentrification across scientific disciplines, including sociology, geography, urban studies and public health. The goals of our review were to (1) clarify key definitions and measures of gentrification in the literature, (2) identify established and proposed dimensions of gentrification relevant to health, (3) create a proposed model of how social, political, and economic factors influence health through residents' lived experiences. We did not systematically search databases or create a formal list of keywords. However, we performed our scoping review broadly using Google Scholar and PubMed with the terms "gentrification" or "neighborhood change" combined with "definition" "survey" "measurement" and/or "health." Additional literature was identified using personal contact with authors, reference lists from identified papers, as well as citation lists of these papers.

Using the identified research from the scoping review, we developed a proposed model of how social, political, and economic factors influence short- and long-term health consequences through residents' lived experience of gentrification (Fig. 1) and an initial set of survey questions. We hypothesized four specific domains (affordability, amenities and businesses, physical environment, and social/cultural dynamics)

and two broad domains (general changes and feelings about changes) of experience of change that were measurable and relevant for health research. In our scoping review, we found no existing survey instrument that assessed residents' lived experience of gentrification-related neighborhood change, apart from other related but distinct perceived neighborhood constructs (e.g., neighborhood disorder, neighborhoodliness, neighborhood amenities). Initial survey questions also included modified versions of these existing neighborhood surveys used in cohort studies (e.g. Multi-Ethnic Study of Atherosclerosis, Jackson Heart Study) by the coauthors or collaborators, including those on social cohesion or trust (Robert J. Sampson, Raudenbush, & Earls, 1997) and neighborhood characteristics (Mujahid, Diez Roux, Morenoff, & Raghunathan, 2007; Saelens & Sallis, 2002).

We conducted multiple rounds of testing to evaluate content validity and quality of these items. In the first step, a national panel of experts with relevant expertise provided feedback on the effectiveness and relevance of the items in measuring the underlying variables. We invited 31 National Neighborhood Indicators Project (NNIP) partner organizations to respond to an online survey and recruited 29 partners from 25 cities (80.6% response) representing communities in every region of the US (Supplemental Fig. S1). NNIP partners were asked to respond using a likert scale (strongly agree to strongly disagree) regarding the usefulness for inclusion (This item is necessary; This item is unnecessary), issues with question design (This item needs clarification), and to identify missing domains and questions. Any items identified by less than 50% of respondents as necessary and 20% or more as unnecessary were dropped from the survey. In a second step, we conducted cognitive interviews with a subset of the 29 partners who responded to the survey (n = 8, 32%) to clarify necessary improvements for all items, establish national relevance of remaining items, and confirm content validity of the entire scale.

Once content validity of the scale was established through expert review, we refined the instrument through multiple rounds of pre-testing. The focus of the pre-testing was the clarity, validity and wording of the survey instrument. In the first step, we presented the instrument during a quarterly meeting of the Pennsylvania and New Jersey American Association for Public Opinion Research (PAN-JAAPOR). PANJAAPOR provides opportunities for public opinion and survey research professionals in the Pennsylvania and New Jersey region to come together, exchange ideas, and network (panjaapor.org). PAN-JAAPOR members (n ~ 25) worked in 6 small groups with each group focused on reviewing one content domain of the instrument. Individuals completed the questions in their assigned section and worked with their small group to develop consensus recommendations on modifications to the format of the questions. In the second step, the revised survey was administered to 12 adult residents of Philadelphia, PA (8), Baltimore, MD (1), Harlem, NY (2), and Iowa City, IA (1). The sample was designed to evaluate whether questions have universal meaning regardless of gentrification experience and length of residence. Specifically, residents were purposely selected across two dimensions: a) tenure within the neighborhood (recently moved versus long-term residents) and b) whether the neighborhood would be classified as experiencing recent or current gentrification using traditional metrics of population and socioeconomic change. Among 4 long-term residents of recently gentrified neighborhoods (median age = 39.5 years), neighborhood tenure ranged from 11 to 62 years. Among 4 new residents of a recently gentrified neighborhood (median age = 31 years), neighborhood tenure ranged from 1 to 4 years). Among 4 residents of neighborhoods that had not experienced gentrification (median age = 48 years), neighborhood tenure ranged from 11 to 41 years. Temple University's Institute for Survey Research (ISR) staff compiled a list of community members and contacted each individual to determine eligibility and willingness to participate. Staff administered the survey orally and then asked respondents for feedback on the questions, including wording, ease of understanding question and response options, and appropriateness of language. In addition, the interviewer requested suggestions to reduce

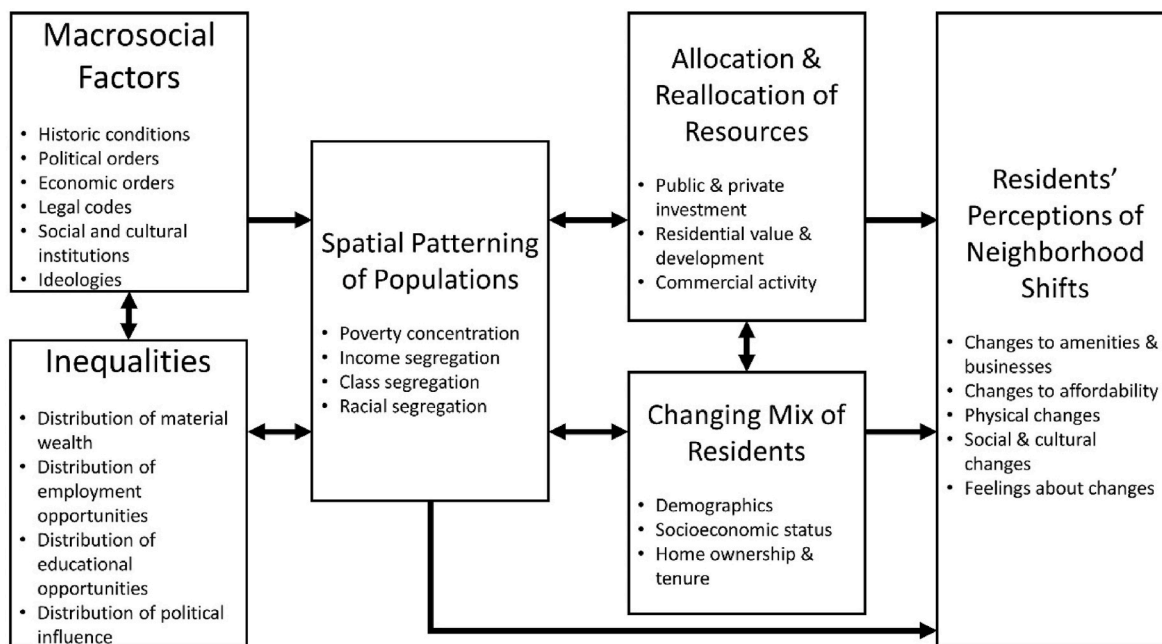


Fig. 1. Proposed theoretical model of upstream social, political, and economic inequalities and determinants that shape residents' perceptions of neighborhood change.

the length of the survey instrument. Respondents were entered into a raffle to win tickets to a local sporting event or a \$30 Visa gift card for their participation.

2.2. Pilot study

PACER was piloted in the BeHeardPhilly (BHP, <http://www.bheardphilly.com/>) Municipal Panel. ISR designed BHP, the first U.S., municipal, blended probability and opt-in panel, to address declining response rates, civic engagement and funding. BHP includes 10,000+ Philadelphians, across all city ZIP codes, recruited via street teams, transit advertising, community events, and probability-based studies. The full BHP sample is diverse with 39% male, 38% non-Hispanic Black, 27% H.S. educated or below, and 46% with incomes less than \$50k. BHP can be weighted to representative of Philadelphia and is the main avenue for non-profits, local organizations, and government departments to collect information from residents on social issues affecting their neighborhoods. A multi-mode panel management software accommodates respondents' preferred contact method (phone, web, SMS). Pilot participants residing in ZIP codes within Philadelphia County and who spoke/read English were recruited from BHP using their preferred mode (e.g. an email preference would generate an email link to the survey). Given that our purpose for the pilot was to test and refine the survey, rather than describe patterns or associations in Philadelphia, we used a non-probability sampling approach recruiting BHP participants from all Philadelphia zip codes. Recruitment continued until we obtained a sample of at least 200 participants (Nov 21-Dec 1, 2019). As per BHP standards, participants who completed the pilot were entered into a raffle for prize tickets. This pilot study was approved by Drexel University IRB and all participants consented prior to completing PACER.

Pilot participants took the full version of PACER, including questions on the context of perceived changes. They were additionally asked residential history (length of tenure in neighborhood, length of tenure in home, home ownership), residential preferences (desire to stay in home, why neighborhood was chosen, whether neighborhood would be recommended as a good place to live), sociodemographics (birth year, gender, race, ethnicity, education, employment, household size, household income), and health (self-reported health and depressive symptoms).

All street addresses were geocoded using ArcGIS 10.4 (ESRI Redland, CA) and an address locator based on a Street Centerline file from the City of Philadelphia. Of the 212 participants who completed the survey, one had an address outside of Philadelphia which did not match and was excluded. Within the remaining 211 participants, 92% (n = 195) matched at the street level with a perfect score of 100 and the remainder matched with scores of at least 88. Addresses were connected to 2010 census tract geographies to evaluate neighborhood sociodemographic and economic data from the American Community Survey (ACS) 2013–2017.

2.3. Analyses of survey metrics and performance

We calculated median and range of time to complete the survey and calculated frequencies of completion mode among all pilot participants. We described sample characteristics using means and frequencies among geocoded participants with complete data.

To empirically test PACER, confirm the validity of items, and identify potential underlying structures or subscales we performed Principal Components Analysis (PCA). All measures were scaled to eliminate correlations that may occur due to differing answer structures (i.e. agree-disagree versus amount of change). We used positive or negative signs to indicate presence or absence of change or presence or absence of positive feelings about change (see final PACER survey, supplemental materials). We ran an initial PCA with components equal to the number of variables to identify factors with eigenvalues greater than 1 (Kaiser criterion (Kaiser, 1960)) and proportion of variance explained greater than 5%. We examined factor solutions to identify one that was reasonable, aligned with theory, and did not leave subscales with insufficient number of measures. After reverse coding questions which loaded negatively to a factor, we ran Pearson's correlation coefficients and calculated cronbach's alpha to measure internal consistency overall and within each scale (factor). Final scores were created as an un-weighted average of the measures within each scale. Higher scores represent more positive feelings about change (factor 1), more environment change (factors 2 and 3), and greater affordability (factor 4).

We assessed data quality by calculating descriptive statistics of subscale scores and Spearman's correlation coefficients of each scale with the others. To understand scale criterion-related validity we

computed Spearman’s correlation coefficients between the scales and the two contextual measures of neighborhood change amount and pace (“On a scale of 1–10 with 10 being the most and 1 being the least, overall how much change has happened in your neighborhood during the last three to five years?”, “On a scale of 1–10 with 10 being the fastest and 1 being the slowest, how quickly have changes been happening in your neighborhood during the last three to five years?”).

We performed all analyses in SAS 9.4 (Cary, NC).

3. Results

Two authors (JAH, YLM) and two other urban health researchers generated 86 survey items based on our scoping review, proposed model, and some existing neighborhood measures (e.g. neighborhood trust and social cohesion (Echeverría et al., 2008)). After categorizing initial items within these hypothesized dimensions of neighborhood change, two survey researchers (KLM, HEG) recommended items to remove to improve clarity, reduce duplicity, and ensure consistency with model content, resulting in a 43 item scale: affordability (k = 8), amenities and businesses (k = 6), physical environment (k = 6), social/cultural dynamics (k = 11), general changes (k = 4), and feelings about changes (k = 8). Multiple items were retained within each dimension, but some redundant questions were removed and questions were modified to ensure appropriate reading level (8th grade).

3.1. Content validity

After eliminating items NNIP partners identified as unnecessary (n = 5), the percent of NNIP partners identifying an item as necessary varied from 42% to 92% among the remaining 37 items. A total of 14 items were identified by more than 30% NNIP partners as needing clarifications. Supplemental Table S1 provides examples of feedback received in interviews with NNIP partners that was incorporated into our final set of questions used in pre-testing. Surveys and interviews did not identify missing dimensions of gentrification-related neighborhood change.

3.2. Pre-testing

Based on input from PANJAAPOR members, we reduced the use of agree-disagree scales and used simpler response options and item-specific response options (Supplemental Table S1). Research suggests that agree-disagree response options require extra cognitive work to understand and result in acquiescence bias, which may differ by race/ethnicity (Smith, 2004; Tourangeau, Rips, & Rasinski, 2000).

Among the community sample (12 residents), we observed no significant differences between groups in their ability to understand and answer questions. This suggested that the instrument was appropriate across differences in neighborhood tenure and gentrification status. Across all resident groups, respondents requested clarity, identified redundancy, and suggested changes in question wording or response choices for some questions (Supplemental Table S1).

3.3. Participant burden and sample characteristics

Completion of PACER and all additional questions (residential, sociodemographic, and health) took a median of 11.0 min (Range 4.7 min–75.4 h). Long completion times often represent a participant who opened the survey link but then left it open on their web browser for a period before filling it out completely or submitting it. Most participants completed the survey through email contact (87.3%), with only 12.7% completing by SMS/text.

Of the 209 geocoded participants who had complete PACER data, a majority were female (56.5%), non-Hispanic White (74.6%), and high socioeconomic status (higher incomes, educations, employment, and home ownership) (Table 2). Respondents lived a mean of 14.9 years (SD 16.2) in their neighborhoods. A majority of respondents would be very

Table 2

Individual and neighborhood characteristics, perceptions about changes in environments and residents (PACER) pilot cohort, BeHeard Philly, 2019 (n = 209).

Characteristic	% (n) or Mean (SD)
Gender (%)	
Male	41.2 (86)
Female	56.5 (118)
Non-binary/prefer not to answer	2.4 (5)
Age (Mean ± SD)	44.5 (13.6)
Race (%)	
White NH	74.6 (156)
Black NH	17.2 (36)
Asian NH	3.4 (7)
Hispanic	2.4 (5)
Multiple races or Other	1.9 (4)
Refused	0.5 (1)
Household income (%)	
Less than 30,000	7.7 (16)
30,000–59,999	20.1 (42)
60,000–99,999	23.0 (48)
100,000–149,999	23.0 (48)
More than 150,000	16.8 (35)
Missing	9.6 (20)
Education (%)	
High school or less	8.1 (17)
Some college or vocational school	14.8 (31)
College graduate or higher	77.0 (161)
Work status (%)	
Employed	77.5 (162)
Unemployed	5.7 (12)
Retired	12.4 (26)
Student	4.3 (9)
Years in neighborhood (Mean ± SD)	14.9 (16.2)
Years in home (Mean ± SD)	12.4 (14.4)
Housing status (%)	
Own	70.8 (148)
Rent	29.2 (61)
Very/Somewhat likely to recommend neighborhood as good place to live (%)	85.2 (178)
Desired length of time to remain in current home	
I would move now	21.5 (45)
Less than 3 years	14.8 (31)
3–5 years	17.2 (36)
More than 5 years but less than 10 years	14.4 (30)
10 or more years	32.1 (67)
Neighborhood Characteristics ^a	
Proportion NH white (Mean ± SD)	0.5 (0.3)
Proportion college education or higher (Mean ± SD)	0.4 (0.2)
Median family income (Mean \$ ± SD)	73363.0 (37574.1)
Proportion age 5+ below poverty level (Mean ± SD)	0.2 (0.1)
Median gross rent (Mean ± SD)	1057.5 (223.4)
Median value for owner units (Mean ± SD)	245053.1 (140246.6)

^a Neighborhood characteristics assigned to participants using census tract 2010 boundaries assigned after geocoding. Data from 2013 to 2017 American Community Survey (ACS).

or somewhat likely to recommend their neighborhood as a good place to live (85.2%), although the desired length of time remaining in their current home appear bimodal with most people saying they would either move now (21.5%) or move in 10 or more years (32.1%). Residential preferences were primarily driven by housing affordability (60%), proximity to public transit (60%), accessibility of goods/services (50%), proximity to work (35%), living near family or friends (32%), and neighborhood safety (32%) (data and other options not shown). Based on ACS census tract data, pilot respondents lived in relatively diverse neighborhoods including neighborhoods with an average of around half non-Hispanic White residents, just under half residents with college degrees, and median incomes just over \$70k (Table 2). These differ from overall ACS data for Philadelphia which has ~80% non-Hispanic White residents, ~30% residents with college degrees, and median income \$57k.

Descriptive characteristics for all piloted PACER questions are provided in Table 3 (final set of formatted survey questions appears in supplemental material). Contextual questions described how people moving into neighborhoods might be different (most respondents indicated income/wealth, age, and racial/ethnic background), overall change and speed of change, and the prominent factors residents associate with driving changes (developers and real estate professionals followed by nearby neighborhoods).

3.4. Internal consistency and dimensionality (PCA)

Final PCA of the 19 non-contextual items with varimax rotation (orthogonal) that provided the best-defined factor structure produced four component scales. All items have primary factor loadings greater than 0.4 (Table 4). Questions primarily about how a resident feels about changes, including those about belonging were included in factor 1. Factor 2 reflected built environment, including items related to physical changes, infrastructure, businesses and amenities. Factor 3 reflected social environment, including items about arrival of new residents or culture shifts. Affordability, particularly as it relates to housing and displacement, were factor 4. Two items (“The cost of housing has increased (i.e. renting or buying)” and “I am afraid of being pushed or forced out of my neighborhood”) had cross-loadings greater than 0.4; they were included with the factor more closely aligned to theory (factor 4). Factor 1 had the highest internal consistency (Cronbach’s alpha 0.81), followed by factor 2 (alpha 0.67), factor 3 (0.65), and then factor 4 (0.60). Cronbach’s alpha for the full set of questions showed good internal consistency (standardized alpha 0.64). Alpha coefficients with deleted variables did not show marked improvement that would support removing a measure.

3.5. Description of scales and criterion-related validity

We calculated the final scores of each scale as the unweighted average across all measures; therefore, the possible range for each four scales differed slightly based on component measure answer types (Table 4). In this sample, respondents felt slightly positive about change (mean 0.29, median 0.43). They reported a relatively high amount of both built environment and social environment change (means 0.70, 0.70 and median 0.80, 0.75, respectively). These were paired with perceived declines in affordability (mean -0.30, median -0.33). Moderate to low Spearman’s correlations between the scales (ranging from 0.19 to -0.40, Table 4), suggested that scales are related but measure different concepts. Correlations were in expected directions: affordability and feelings were positively correlated with each other and both were negatively correlated with increased built and social environment change. Correlations comparing the scales to two single-item questions regarding neighborhood change amount and pace were in the expected directions, providing criterion-related validity (Table 4). More and faster overall changes were negatively associated with feelings about changes and perceived affordability. Reporting more built and social environment change was positively associated with the amount and pace of overall change.

4. Discussion

We developed and tested a survey instrument to assess perceptions of gentrification-related neighborhood change in research investigating the effects of gentrification on health and wellness outcomes. We ensured content validity of scale items through use of a scoping literature review to identify relevant domains and multiple rounds of expert input prior to measurement and testing. We established the reliability and validity of the resulting 19 items within four specific domains (feelings, affordability, built environment, and social environment).

We found one existing comprehensive instrument evaluating residents’ perceptions of gentrification (DeVylder et al., 2019), not available

Table 3
Original 27 PACER variables with descriptive statistics. (R) denotes item is reverse coded. Descriptive statistics calculated after each item was reverse coded.

Label/Name	Variable	Mean (SD)	N (%)
	Amount of Change: <i>Thinking about changes in your neighborhood please identify the degree to which the following changes have happened. When answering these questions, think about the ways your neighborhood may have been changing in the past three to five years or the way it is currently changing.</i>		
New	New businesses are opening	1.09 (0.97)	
Replace	Long-standing businesses are being replaced by different businesses.	0.78 (1.00)	
Grocery	More expensive or fancier grocery stores are opening	0.14 (1.24)	
Housing	The cost of housing has increased (i.e. renting or buying) (R)	-1.49 (0.78)	
	The costs of necessary expenses other than housing have increased (e.g., childcare; groceries; transit) (R)	-0.70 (1.06)	
Buildings	Construction of new buildings on vacant lots or to replace old buildings	1.16 (1.10)	
Resources	Construction of new or improved resources, such as parks, bike lanes, transit, or sidewalks	0.34 (1.15)	
Flipping	People are “flipping” properties, buying and fixing them up to rent or sell.	1.33 (0.85)	
Neighbors	Changes are leading to tension or conflict between me and my neighbors	0.05 (1.15)	
People	There are a lot of new people moving into my neighborhood*	1.08 (1.28)	
	In what ways are people who are moving into your neighborhood different than you? (check all that apply)		
	Income or wealth		77 (0.37)
	Age		54 (0.26)
	Racial or ethnic background		44 (0.21)
	Job or employment		36 (0.17)
	Culture and values		35 (0.17)
	Family structure		33 (0.16)
	None: people moving into my neighborhood are the same as me		28 (0.13)
	Education		26 (0.12)
	The activities they enjoy		25 (0.12)
	They are students		21 (0.10)
	Other		16 (0.08)
	Religion		10 (0.05)
	People moving into your neighborhood call it by a different name than long-term residents (respondents choosing yes)		135 (0.65)
	How much interest do people moving into your neighborhood take in existing businesses or organizations (e.g., churches, neighborhood associations, schools) (R)	0.38 (1.26)	
Amount	On a scale of 1–10 with 10 being the most and 1 being the least, overall how much change has happened in your neighborhood during the last three to five years?	6.28 (2.16)	
Pace	On a scale of 1–10 with 10 being the fastest and 1 being the slowest, how quickly have changes been happening in your	5.83 (2.34)	

(continued on next page)

Table 3 (continued)

Label/Name	Variable	Mean (SD)	N (%)
	neighborhood during the last three to five years? What do you feel is the most important factor driving changes to your neighborhood? Select one. Developers and Real Estate Professionals		91 (43.54)
	Nearby neighborhoods		29 (13.88)
	Other (please list)		22 (10.53)
	Businesses		16 (7.66)
	People from outside of my city (excluding tourists)		15 (7.18)
	University, Hospital, or Private Institution		11 (5.26)
	School quality		9 (4.31)
	Internal organizations (e.g. community groups and non-profits)		8 (3.83)
	Government (e.g. city, state, or national)		4 (1.91)
	Infrastructure changes		3 (1.44)
	Tourism		1 (0.48)
	New or modified transit		0 (0.00)
	Feelings About Changes: <i>These questions will ask for your feelings about any changes within your neighborhood.</i>		
Afford	If I had to move right now, I could afford to move to a similar house or apartment within my neighborhood	-0.06	(1.40)
	In my neighborhood, available housing to rent or buy is not affordable to me	-0.10	(1.24)
Welcome	I feel welcome in most new businesses in my neighborhood	1.10	(0.95)
Personality	I feel the personality of my neighborhood has changed	0.35	(1.18)
Trust	I trust people moving into my neighborhood	0.30	(1.01)
Good	I feel good about the changes happening in my neighborhood	0.10	(1.10)
Pushed	I am afraid of being pushed or forced out of my neighborhood (R)	0.65	(1.24)
Support	I would support changes to my neighborhood (e.g. new stores, sidewalks, parks) even if the changes make it more expensive for me to live here	0.43	(1.15)
Meant	Changes in my neighborhood are meant for people like me	0.29	(1.20)
Unsure	Changes happening in my neighborhood make me feel unsure that I will stay here. (R)	0.38	(1.26)
Say	I feel I have a say in what changes occur in my neighborhood	-0.57	(1.17)

Bolded variables are included in final PACER scale.

Variables with an (R) indicate which have been reverse-coded during analyses.

^a This question changed to “New people are moving into my neighborhood” for final survey (see supplement)

during our scoping review. The NCGS, developed for social work research, consists of 10 items and two subscales (neighborhood disruption and neighborhood gentrification). Like our feelings and social environment subscales, the NCGS neighborhood disruption subscale (k = 6) measures negative perceptions of displacement and shifts in neighborhood dynamics. The NCGS neighborhood gentrification subscale (k = 4) measures new physical and financial resources, incorporating similar concepts as our physical environment and affordability subscales. Our scale allows for a greater differentiation of measured perceptions that may be differentially related to health outcomes. For example, it is hypothesized that residents of a gentrifying neighborhood may have increased access to health promoting built environment characteristics, such as grocery stores or improved sidewalks and bike

paths. Alternatively, these residents may experience reduced affordability related to increased rents or goods. While these different pathways cannot be meaningful distinguished by the NCGS, they represent unique subscales in PACER. The process for generating items or evaluating content validity of the NCGS instrument was not described.

PACER and this study are not without limitations. Since PACER was designed using theory and input around gentrification (one type of neighborhood change), it may be less suitable for measuring other types of change, particularly those related to declines in neighborhoods (e.g. disinvestment or disaster). PACER was developed and tested using experts and residents from varying urban areas within the U.S that captured East Coast, Midwest, Southern, and West coast cities with diverse infrastructure ages, development histories, political climates, social structures, and other urban elements. However, the focus on US cities may restrict generalizability to suburban, rural, and international contexts. Additionally, the survey sample was recruited using quota sampling rather than probability sampling methods, and therefore may not be representative of Philadelphia, or other U.S. cities. Specifically, the sample used were predominantly white, well educated, and high-income individuals who might have different views of neighborhood change. While this may change the levels of measures, we do not anticipate that it would shift factor loadings or correlations between scales. PACER should be tested across a wider range of socioeconomic, racial, and neighborhood change strata or replicated in larger, probability or population-based samples when the opportunity arises. Translation of PACER to common languages in the U.S. (Spanish, Chinese/Mandarin, Tagalog, French, and Vietnamese) will enhance generalizability and usability.

We identified several key issues related to gentrification and neighborhood change that may be important areas of future research and ongoing scale refinement including geography, time, and relevant perspective. First, experts and community members raised the issue of how to define a meaningful neighborhood for understanding the influence of change on health. In PACER, instructions directed respondents to “... think about the neighborhood around your home” without further defining or limiting “neighborhood” for respondents. Research demonstrates that meaningful neighborhood scale may vary by population, exposure, or association (Cagney, Browning, & Wen, 2005; Diez; Mavoa et al., 2019; Diez Roux, 2001). Because existing measures of gentrification primarily rely on Census-derived characteristics, most gentrification-health research has focused on census geography (county, census tract or block group) (Bhavsar et al., 2020; Ding et al., 2016; L.; Freeman, 2005; Hammel & Wyly, 1996). With the development of scales that consider residents’ perceptions, it will be important to consider the relevance of different neighborhood boundaries in order to determine the most meaningful definitions for this type of research. This may lead to refined instructions for participants or researcher guidance regarding the appropriate geographic scale for aggregating responses. Second, we refined our time scale for measurement during our expert interviews and confirmed these during our pre-testing with community members with variable neighborhood tenure. Longitudinal research assessing neighborhood change is limited (Chandrabose et al., 2019; Diez Roux et al., 2016; Kärmeniemi et al., 2018; C; Mair et al., 2015; Moore et al., 2016; Tcymbal et al., 2020). While our research confirmed that 3–5 years was appropriate, additional testing and evaluation is needed to consider the influence of different time scales for assessing change. Third, while our goal was to quantify perceptions of individual residents, feelings about change may vary by race and neighborhood tenure (Sullivan, 2006), as well as housing ownership status. As evidenced during the COVID pandemic and resulting economic downturn, physical and mental health risk varies considerably by race and housing ownership status (Mackey et al., 2021; Neal & McCargo, 2020). Social psychology models posit that our individual histories influence the mental associations we assign to emotions which are expressed as feelings (Fredrickson, 2001). In our evaluation of content validity and pre-testing, we attempted to ensure that our questions were meaningful and understood similarly across

Table 4
Internal consistency, dimensionality, and criterion-related validity of PACER using Principal Components Analysis (PCA).

	Factor 1		Factor 2		Factor 3		Factor 4	
	Feelings		Built Environment (Businesses & Amenities)		Social Environment (Residents)		Affordability	
	Question	Factor loading ^a	Question	Factor loading ^a	Question	Factor loading ^a	Question	Factor loading ^a
	<i>Support</i>	0.73003	<i>New</i>	0.76272	<i>Neighbors</i>	0.6935	<i>Housing</i>	0.43105
	<i>Say</i>	0.71692	<i>Grocery</i>	0.68251	<i>Personality</i>	0.66703	<i>Afford</i>	0.77667
	<i>Good</i>	0.67847	<i>Buildings</i>	0.68093	<i>People</i>	0.60081	<i>Pushed</i>	0.63922
	<i>Trust</i>	0.606	<i>Replace</i>	0.47722	<i>Flipping</i>	0.50573		
	<i>Meant</i>	0.6034	<i>Resources</i>	0.40576				
	<i>Welcome</i>	0.5458						
	<i>Unsure</i>	0.54286						
Internal Consistency								
Eigenvalue	4.36		3.37		1.36		1.01	
Cumulative variance explained (%)	22.95		40.69		47.85		0.5319	
Standardized Cronbach's alpha	0.81		0.66		0.65		0.6	
Descriptive Statistics								
Possible Range	-2.0 to 2.0		-1.0 to 2.0		-1.25 to 2.0		-2.0 to 1.66	
Mean (SD)	0.29 (0.77)		0.70 (0.72)		0.70 (0.78)		-0.30 (0.87)	
Median (IQR)	0.43 (-0.29, 0.86)		0.80 (0.20, 1.20)		0.75 (0.25, 1.25)		-0.33 (-1.0, 0.33)	
Corr w/factor 1 ^b	1		0.19189		-0.31932		0.38707	
Corr w/factor 2 ^b	0.19189		1		0.31286		-0.25411	
Corr w/factor 3 ^b	-0.31932		0.31286		1		-0.4045	
Corr w/factor 4 ^b	0.38707		-0.25411		-0.4045		1	
Correlation w/Amount ^b	-0.21323		0.31791		0.57226		-0.32214	
Correlation w/Pace ^b	-0.22665		0.2994		0.5812		-0.32131	

^a Table shows only factor loadings for the factor each question loaded onto. In instances with relatively even loading (i.e. Housing) we loaded with the factor best suited by theory/content.

^b All correlations are Spearman's Correlation coefficients.

groups that differ by amount of gentrification-related neighborhood change and neighborhood tenure. However, additional research is needed to better understand the influence of individual characteristics such as race or housing status on perceptions and how these factors may modify the influence of changes on health. Given the above, we recommend that researchers seeking to adapt PACER to their local context should collaborate with community groups or residents to gain clarity on: a) appropriate and perceived neighborhood boundaries; b) what time scale feels meaningful, c) ways questions might be interpreted differently by different local populations, and d) translation into languages and syntax appropriate for local populations. This would ideally be done with formal partnerships but may take the form of focus groups and cognitive interviews.

The current research has a number of notable strengths. The development process was comprehensive and followed best practices for scale development (Boateng, Neilands, Frongillo, Melgar-Quinonez, & Young, 2018). We included content experts and community members in our content validity and pre-testing process. The empirical tests of measure were generally consistent with our model of gentrification, which was informed by a broad, interdisciplinary review of literature. Based on this model, PACER was designed to assess health-relevant aspects of neighborhood change identified in prior research.

5. Conclusion

PACER offers an unprecedented tool for measuring and understanding resident perceptions about gentrification-related neighborhood change relevant to health. Future reliability studies should compare PACER to existing measures of gentrification that have been operationalized using GIS, census data, or other surveys (i.e. NCGS and SummerStyles/HealthStyles) and assess associations with potential health outcomes. Research with PACER should evaluate physical or mental health outcomes among resident populations reporting different levels of or feelings about neighborhood change. Ultimately, PACER is a step forward for Public Health to understand residents' experiences of gentrification-related changes across many different U.S. settings.

Author statement

JH and YM conceived of the original project, performed the scoping review, gathered neighborhood and survey expert feedback, and performed expert cognitive interviews. HG and KM performed community cognitive interviews, formatted PACER for implementation, and both recruited and completed the BHP pilot data collection and cleaning. All four authors revised the PACER questionnaire at all steps. JH and YM performed analyses for this manuscript. All authors drafted, read, and approved the final manuscript.

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Declaration of competing interest

The authors declare no conflicts of interest.

Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.ssmph.2021.100900>.

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