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The body language of place: A new method for mapping intergenerational “geographies of embodiment” in place-health research

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ABSTRACT

Research on place and health has grown rapidly in recent years, including examining the physiological embodiment of place-based exposures. While this research continues to improve understanding of why place matters, there is particular need for work capable of revealing: 1) *which* places matter, i.e. spatially-specific notions of “place”; 2) *how* these places matter—processes and mechanisms of the physiological embodiment of place; and 3) potential intergenerational and life stage differences in place-embodiment experiences/perceptions. The research presented here seeks to make contributions in each of these areas through developing the “geographies of embodiment” concept. Drawing from a multi-method intergenerational community-based participatory research project examining place and health, the research presented here specifically highlights *X-Ray Mapping* as a new methodology to elucidate subjective notions of place-embodiment within place-health research. Participants were recruited as parent-child dyads and trained in four participatory research methods, including *X-Ray Mapping*. Participants used *X-Ray Mapping* and a multimedia-enabled web-based mapping platform to map their “geographies of embodiment”. *X-Ray Mapping* results revealed that 49% of youth place-embodiment locations were spatially outside of their residential census tract—with 75% of *positive* place-embodiment locations outside, and 66% of *negative* place-embodiment locations inside. Overall, 67% of youth and adult *positive* place-embodiment locations were outside of their residential census tract. Through mapping “geographies of embodiment” via participatory methods like *X-Ray Mapping*, we can gain greater insight into what is embodied (i.e. specific experiences/exposures), and where (i.e. spatially-specific). These gains could improve development of quantitative place-health metrics and enhance efforts to uncover/intervene on the “pathways of embodiment”—specifically, those elements of local social, political, economic, and environmental contexts that constitute expressions of social inequality.

1. Introduction

Place-health research has grown rapidly over the last fifteen years (Roux et al., 2010; Ellen et al., 2001; Pickett and Pearl, 2001; Riva et al., 2007; Sampson et al., 2002). However, major conceptual and methodological challenges remain in defining “place”, characterizing place contexts, and measuring place (Bernard et al., 2007; Chaix et al., 2009; Cummins, 2007; Cummins et al., 2007; Cutchin, 2007; Diez Roux, 2004; Roux and Ana, 2001; Frumkin, 2006; Kwan, 2009, 2012; Macintyre et al., 2002; Matthews, 2008; Merlo, 2011; Mujahid et al., 2007; O’Campo, 2003; Rainham et al., 2010; Spielman and Yoo, 2009)—all of which have implications for place-health research, public health practice, and the design and implementation of place-based

strategies. One area of place-health research that is especially beholden to these challenges is work examining the physiological *embodiment of place* and how it affects health and well-being over time.

Scholars within health geography (Dorn and Laws, 1994; Hall, 2000; Kearns, 1997; Parr, 2002) and feminist geography (Dyck, 2003; Katz, 2001; Longhurst, 1997), have long called for more explicit centering of the body as both a site and vehicle of social production, social reproduction, and resistance within health studies. The body, from these perspectives, is not an un-gendered, un-sexed, un-racialized biological mass and site of disease inscription existing in apolitical space. Rather, bodies are simultaneously social and biological, and both products and (re)producers of social and political relations structured by and within power hierarchies. The health state of bodies, as both

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objectively presenting and subjectively represented, thus reflects embodied social relations. Likewise, scholars within political ecology of health (Guthman and Mansfield, 2013; Harper, 2004; Jackson and Neely, 2015; King, 2010) have argued for a “biosocial” perspective of the body in geographic space. They highlight the imperative of situating health within a broader ecological framework that includes not only biological bodies, but also natural, chemical, built, and social environments, along with the larger social, economic, and political structures that shape distributions and spatial configurations of health exposures encountered within local spaces. This work is similarly concerned with the “geographic processes that produce and reproduce healthy (and unhealthy) bodies” (Jackson and Neely, 2015, p.56; italics in original)—processes that include the (re)production of spatial knowledge of/about bodies. From these perspectives together, mapping geographies of health (e.g. as in place-health research) without concomitant mapping of where, how, and specifically whose bodies are affected within these geographies strips away agency and obfuscates the forces responsible for producing the spatialized contexts and conditions that become embodied as health/illness. As articulated by Dorn and Laws (1994, p.108), “we need to re-think places as they are contested in embodied social practices.” Thus understanding the geography of health, at its core, necessitates understanding the geography of embodiment, and who is mapping/speaking on behalf of whose bodies.

In public health perhaps the most developed and useful notion of embodiment is that articulated by Krieger (1994, 2001) through ecosocial theory. *Ecosocial theory* integrates the full spectrum of processes and levels that influence health, from the sociopolitical structural forces of societies down to the physiological processes and molecular mechanisms of cells. As described by Krieger (2001, p.672), the ecosocial approach “fully embraces a social production of disease perspective while aiming to bring in a comparably rich biological and ecological analysis.” Additionally, ecosocial theory situates health and its determinants within a historical, generational, and lifecourse perspective. As a foundational construct of ecosocial theory, *embodiment* is understood as the process through which the outside physical and social world becomes embedded into our biology—that is, how daily interactions with our social and physical environments “get under our skin” to affect our physical, psychological, and emotional well-being by altering how our body functions (Krieger, 2001). We encounter and incorporate myriad physical and social exposures and experiences on a daily basis, whether such incorporation be biological or chemically direct (e.g. air pollution) or psychosocially mediated (e.g. experience of discrimination), and whether we do so consciously or unconsciously. Importantly, then, embodiment is continuous, and is both objective and subjective. This notion of embodiment does well to frame the health significance not only of people interacting with and within natural and built environments, but also the critical import of understanding the architecture of social and political systems that structure relational aspects of people within and across ecological levels (e.g. body, household, neighborhood, region, nation) (Krieger, 2005). This architecture—the so-called *pathways of embodiment*—involves the underlying “societal arrangements of power and property and contingent patterns of production, consumption, and reproduction” that influence health within “constraints and possibilities of our biology” (Krieger, 2001, p.672). This notion of embodiment thus speaks aptly to considerations of/for the body put forth in health geography, feminist geography, and political ecology, as discussed above.

Given that our bodies exist within particular social contexts as we move through physical and social space, embodiment as a phenomenon is inherently tied to notions of place. Within the broader place-health field, there is a growing amount of research examining how elements of place become embodied to affect physiological function and health (Petteway et al., 2019). Though this work has not necessarily been referred to or self-identified as “place-embodiment” research, it has indeed focused on explicating how “the outside physical and social world becomes embedded into our biology,” connecting measures of place to

measures of physiological (dys)function. Specifically, this work has focused primarily on exploring two core physiological mechanisms/processes underlying place-embodiment, *allostatic load* (McEwen, 1998; Seeman et al., 2010) and *weathering* (Geronimus, 1992; Geronimus et al., 2006). As such, place-embodiment research at the population level often entails the collection and spatial analysis of biometrics, e.g. cortisol (Barrington et al., 2014; Do et al., 2011; Rudolph et al., 2014), inflammatory markers (Broyles et al., 2012; Merkin et al., 2009; Nazmi et al. 2010), and telomere length (Gebreab et al., 2016; Geronimus et al., 2015; Needham et al., 2014; Park et al., 2015; Theall et al., 2013), in relation to what are considered core social determinants of health, such as socioeconomic status (SES). And it appears more often than not, SES or a related measure of “neighborhood” disadvantage is the primary measure of place used to characterize the spatial contexts of embodiment (Petteway et al., 2019), e.g. work revealing how living in a low-SES neighborhood affects measures of inflammatory markers (see for example Petersen et al., 2008). Moreover, existing research has been almost exclusively quantitative, relying heavily on survey-based and biometric-focused approaches (Petteway et al., 2019), with what appears to be a complete absence of qualitative place-embodiment work in the place-health literature.

Research to date certainly invites us to probe deeper into the notion of place-embodiment within public health. However, if the ultimate goal is to correctly specify the processes and mechanisms through which “place” becomes biologically incorporated over time, it is of paramount importance that pertinent and *specific* physical and social exposures/experiences, and their corresponding spatial locations, patterns, and geographic distributions, are elucidated and accounted for. Moreover, given the cumulative and dynamic nature of embodiment (Krieger, 2005), and the health significance of place contexts across the lifecourse (Curtis et al., 2004; Gustafsson et al., 2014; Merlo, 2011; Nazmi et al., 2010; Pearce et al., 2016), considerations of life stage and lifecourse perspectives are critical in optimizing our ability to appropriately gauge and weigh place experiences and exposures that might vary over time and/or be generationally- or life stage-contingent, e.g. age-related differences in the perception and appraisal of social/physical environments. On the most basic level, adults and youth encounter and experience drastically different places on a day-to-day basis. Appraisals of and responses to these encounters/experiences are inextricably linked to age and life-stage. Appreciating this is especially important given that *subjective* measures of place (not just objective ones) matter in the context of health (Lin and Moudon, 2010; Pruitt et al., 2012; Schulz et al., 2013; Weden et al., 2008; Wen et al., 2006) and place-embodiment (Barrington et al., 2014; Gebreab et al., 2016; Park et al., 2015; van Deurzen et al., 2016), with recent research revealing the age- and life-stage contingency of place-embodiment measures, exposures, and perceptions/appraisals thereof (Brenner et al., 2013; Crimmins et al., 2003; Curtis et al., 2004; Goldman-Mellor et al., 2012). Thus, there remains particular need for place-embodiment work capable of revealing: 1) *which* places matter, i.e. spatially-specific notions of “place”; 2) *how* these places matter—that is, identification of specific place-based exposures/experiences to enable continued exploration of processes/mechanisms underlying (and driving spatial patterns) of place-embodiment; and 3) potential intergenerational and life-stage differences in place-embodiment exposures, experiences, and perceptions.

The research presented here seeks to make contributions in each of these areas through developing the “geographies of embodiment” concept. This research was completed as part of the *People's Social Epi Project* (PSEP)—a multi-method intergenerational community-based participatory research (CBPR) project examining place, embodiment, and health. This paper specifically highlights *X-Ray Mapping* as a new cognitive mapping methodology to elucidate subjective notions of place-embodiment within place-health research, and enable the construction of “geographies of embodiment” that can inform efforts to arrive at generationally/life-stage-contingent, and spatially-specific

measures of place-health exposures and experiences.

This paper begins with an overview of the PSEP process and methods for context. This paper then details the X-Ray Mapping methodology and findings, including data illustrations from a web-based multimedia-enabled community mapping platform. The paper closes with a discussion of findings and the potential utility of the X-Ray Mapping methodology in complementing and enhancing place-embodiment research, as well as possible applications/implications for intergenerational and participatory place-health research and practice going forward.

2. The People's Social Epi Project: an intergenerational study of place, embodiment, and health

2.1. Background

The People's Social Epi Project (PSEP) was a multi-method intergenerational community-based participatory research (CBPR) project examining place, embodiment, and health that used information and communication technologies (ICTs) to facilitate and enhance the research process. PSEP was developed and executed with an orientation anchored in *A People's Social Epidemiology* framework (Petteway, 2014a), a multicomponent and tiered framework to guide social epidemiology research/practice to become more inclusive and equitable, improve knowledge translation, and facilitate timely, locally relevant action. PSEP integrated social epidemiology and CBPR principles in collaboration with parents and youth residing in public housing to understand where and how place-based exposures that affect health and well-being are encountered, perceived, and experienced intergenerationally within 5 broad place-domains: *Home, Neighborhood, School/Work, Social/Leisure, and Transition routes/spaces*. The aims of this work were to: 1) determine the spatial distribution of adult and youth daily places; 2) characterize adult and youth perceptions of health and place-embodiment for their daily environments; and 3) assess spatial differences of “place”, and perceptual differences of health and place-embodiment between adults and youth. Taking a *placescape* approach (Petteway, 2014b), the research was completed using participatory methods for the documentation and assessment of place-based exposures and opportunities with two generations of public housing residents—one parent and at least one youth from each participating household recruited as parent-child dyads. Research processes and findings presented here are from the first iteration of PSEP.

2.2. Study setting

Adult and youth participants were recruited from a public housing project in a small Midwestern industrial city where one of the authors was a former resident. For context, the city has experienced significant population loss since the 1980s and has maintained a population health profile significantly worse than national averages and those for nearby major cities (e.g. Pittsburgh, Cleveland). The city has been and remains quite racially and economically segregated, and the core of local political leadership has been overwhelming white. For example, during this project, an African American woman was appointed health commissioner—marking the first time in the city's history that a person of color held a leadership role within a core agency.

Within this context, the public housing community was identified as a research collaborator for four core, overlapping reasons. First, the research focus of the project was exploring place and health specifically among public housing residents, as there is limited work to date despite public housing residents having much worse health profiles than the general population (Burton et al., 2002; Fertig and Reingold, 2007; Harris and Kaye, 2004; Howell et al., 2005; Keene and Geronimus, 2011; Manjarrez et al., 2007). Second, public housing communities tend to be very multigenerational and residents tend to stay for long periods of time, making them well-suited for exploring

intergenerational and spatially-dynamic notions of “place” and health among residents who share same places (i.e. housing unit and housing community). Third, the city was in the process of a) completing its comprehensive city plan and b) closing its local health department and merging it with the county health department. Neither process engaged public housing residents. Moreover, about 75% and 60% of the county's Black and Latino populations, respectively, reside in the city, and the city's child poverty rate (about 40%) is twice that of the county. Fourth, and last, the city had never completed a community population health assessment, had never tracked or reported indicators of neighborhood health or local social determinants, and had never had an actual epidemiologist on staff for generating/tracking local population health data. Thus collaboration with this particular housing community allowed for the joint exploration of research objectives and the simultaneous pursuit of community health representation.

2.3. Participants and process

Recruitment and all project activities were planned and completed in collaboration with a local adult resident co-lead who was trained in human subjects research (via Collaborative Institutional Training Initiative). Youth were between ages 13 and 18 and had to be enrolled in school. Adults had to be formally employed or have some form of daily non-leisure activity (e.g. child care, doing hair, informal side jobs). Prior to commencing the formal research, all participants were trained in public health basics and core principles related to social epidemiology and health equity, and trained in public health research and CBPR basics. Trainings included formal presentations covering core background material and illustrating key project-related concepts and methods, as well as more open-ended and participant driven discussion. A total of 8 adults and 10 youth were initially enrolled as participants. A total of 4 adults and 7 youth completed all project trainings and research activities, and data presented here are based on their work.

All research methods were completed by the participants themselves. Youth and adults completed the same methods simultaneously but in separate all-youth and all-adult groups. Informed consent and assent were obtained after the initial training, followed later by method-specific informed consent and assent. Participants received a cash participation stipend on a per-meeting basis. All project meetings were held at a public recreation center located adjacent to the housing project, with the exception of two meetings held at a public library branch located about half a mile from the housing community. An informal project advisory board consisted of three staff members at the recreation center, one adult public housing community resident, and one at-large city council member serving on health and education committees. All project activities, including recruitment, were co-coordinated and co-led with an adult project co-lead from the housing community who was trained in human subjects research. PSEP protocols were approved by the University of California, Berkeley Institutional Review Board. Research methods flowed sequentially and built upon each other, as follows:

- 1) Photovoice
- 2) Activity Space Mapping
- 3) X-Ray Mapping
- 4) Participatory GIS

First, for *Photovoice* (Catalani and Minkler, 2010; Wang and Burris, 1997), participants photo-documented (via smartphones) their important daily places and specific exposures/opportunities within each place they perceived as affecting their health, positively or negatively. With guidance from a facilitator, they then narrated each photo (in writing) to describe their experiences/perceptions of embodiment and health for each photo-place (detailed in Petteway, 2015). Second, for *Activity Space Mapping*, participants geolocated and mapped *Photovoice* photo-locations and identified additional non-photographed places

using large print-out maps. They also numerically rated each mapped place for health, designating their ratings using color-coded stickers (see Petteway, 2017 for details). Third, participants used these data to create symbolic representations of how each of these mapped photo-places affects their bodies/health using a cognitive mapping method known as *X-Ray Mapping* (discussed in detail below). Lastly, constituting *Participatory GIS*, participants integrated and digitally mapped their work via a web-based, multimedia-enabled information and communication technology (ICT) platform, *Local Ground* (Van Wart et al., 2010). This platform allowed participants to create, print, and digitally share their place research maps with each other, the broader community, and city officials.

2.4. The X-Ray Mapping method: elucidating subjective notions of place-embodiment

2.4.1. Background

X-Ray Mapping is a cognitive mapping method that can elucidate how social and built environment experiences become physically embodied (Ruglis, 2011). Given that embodiment is both objective and subjective, accounts of embodiment, and the recounting of embodiment experiences, must account for whom/what is speaking for/on behalf of the body. X-Ray Mapping as a method thus embraces feminist notions of situated and decolonized knowledge (Haraway, 1988; Smith, 2013), enabling people to (re)claim power over the health narratives of their own bodies based on their embodied knowledge of daily place-based experiences. In doing so, this method parallels similar qualitative processes and feminist methods that have been used in other fields. Most notably, “body mapping” or “body-map storytelling” has been used within medical anthropology (Cornwall, 1992), occupational health (Gastaldo et al., 2012; Keith and Brophy, 2004), cultural psychology (Lykes and Crosby, 2013), and city planning (Sweet and Ortiz Escalante, 2015) to elicit respondents' perceptions of how certain experiences or environments affect their bodies. The goal for X-Ray Mapping in the present study was to understand how participants perceive that their daily places affect their health—specifically, how their places “get under their skin” and affect their bodies. Through describing which areas of their body are affected by place and how they are affected (e.g. positively, negatively), participants are able to tell a story of how their bodies experience place. This process qualitatively captures subjective notions of the embodiment of place. To the authors' knowledge, “X-Ray Mapping” as a terminology and a method has not been used in the public health or any place-health literature to date.

2.4.2. X-Ray Mapping process and data collection

Prior to commencing the X-Ray Mapping method, all participants attended a 2-h training and discussion session. This session included a 20 min presentation summarizing what X-Ray Mapping is and what it would entail for participants. Informed consent and assent specific for X-Ray Mapping were obtained after this presentation. Participants were then provided with basic training in the notion of “embodiment” and related processes/concepts of stress, allostasis, allostatic load (McEwen, 1998), and “weathering” (Geronimus, 1992; Geronimus et al., 2006). This training included open-ended and participant-led question/discussion of the concepts and the sharing of example illustrations of each as they had experienced them based on their own interpretations.

Following the training session, each participant attended 2 or 3 sessions to complete the X-Ray Mapping methodology. For this method, participants worked with 8.5“×11” “X-Ray Map” worksheets containing a basic body outline with ventral and dorsal representation on the front side of the paper (Fig. 1). They were asked to think about and describe what their bodies/minds feel in each place they identified during the *Photovoice* and *Activity Space Mapping* exercises and complete an X-Ray Map for each place—that is, each photo-documented and mapped place would have a corresponding X-Ray Map to represent how they perceived that particular place affected them physically,

psychologically, and/or emotionally. So for example, a participant might take a photo of a park during *Photovoice*, then map that photo location during *Activity Space Mapping*. Then they would complete the *X-Ray Mapping* worksheet specifically for that photo-place, using the worksheet to indicate how they perceive that particular park affects their body/health. This was repeated by participants for each of their place locations identified via *Photovoice* and *Activity Space Mapping*.

Participants were instructed to locate their perceived place-embodiment effects on their X-Ray Maps using color-coded stickers *Photo 1*. Participants expressed a desire to continue the color representation scheme used for the *Activity Space Mapping* method, which used green for positive (or healthy/good) places, red for negative (or unhealthy/bad) places, and yellow for places they believed had both positive and negative effects. Hence, for X-Ray Mapping, green represented a perceived positive body effect, red represented a negative effect, and yellow represented both a positive and negative effect. For example, if they say that visiting a friend's apartment makes them happy, then they would place a green sticker on the head/brain and/or heart of their X-Ray map. If they say that crime in their neighborhood makes them feel nervous or makes their heart beat faster, then they would place a red sticker on the head and/or heart area. Or if they say that a particular park is good for exercising but people often smoke there, then they would notate it by placing a yellow sticker on the lungs, for example (or alternatively they could use separate red and green stickers). Participants were free to use as many stickers as they believed necessary to capture all of their perceived place-embodiment effects for each place, such that each X-Ray Map could contain multiple positive and negative effects (e.g. positive heart, negative brain, and negative back) and each body area/part could have multiple stickers of the same or different colors (e.g. two positive and three negative brain effects). Participants were instructed to use the back of their X-Ray Map worksheets to write a brief description/narrative explaining their place-embodiment representations.

2.4.3. X-Ray Mapping analysis

Fig. 2 shows a completed X-Ray Map example, and *Text Box 1* shows an example place-embodiment narrative corresponding to a completed X-Ray Map. Each X-Ray Map was reviewed to complete simple counts and frequencies of: 1) place-embodiment geographic locations (based on the 5 overall PSEP place-domains of *Home*, *Neighborhood*, *School/Work*, *Leisure/Social*, and *Transition*), 2) place-embodiment physiologic locations (e.g. heart, brain, stomach), and 3) type of perceived place-embodiment effect, i.e. positive, negative, both (yellow stickers were counted as one positive and one negative effect). This was done for each individual participant separately. Once individual place-embodiment tabulations were completed, results were aggregated for youth and parents separately. Aggregate summary tables were produced for overall adult and youth place-embodiment data, as well as domain-specific adult and youth place-embodiment data (Tables 1–3).

Qualitative comparisons were made between aggregate youth and aggregate adult X-Ray data (e.g. youth neighborhood embodiment X-Ray Map vs. adult neighborhood embodiment X-Ray Map). Tables 1–3 summarize intergenerational perceptual differences of place-embodiment by place-domain. Summary infographics were developed in collaboration with youth participants to visually represent place-embodiment among adult and youth participants (Figs. 3–6). All X-Ray Map data was then mapped on the *Local Ground* platform to enable geographic visualization and qualitative comparison of adult and youth “geographies of embodiment”. Participants retained access to their individual data and *Local Ground* account throughout the project. Completed aggregate analyses were shared and discussed with adult participants during one follow-up meeting, and with youth over three follow-up meetings. These meetings allowed participants to reflect on the aggregate data, provide feedback on visualizations, and collectively verify geographic locations to their knowledge and intended representation.

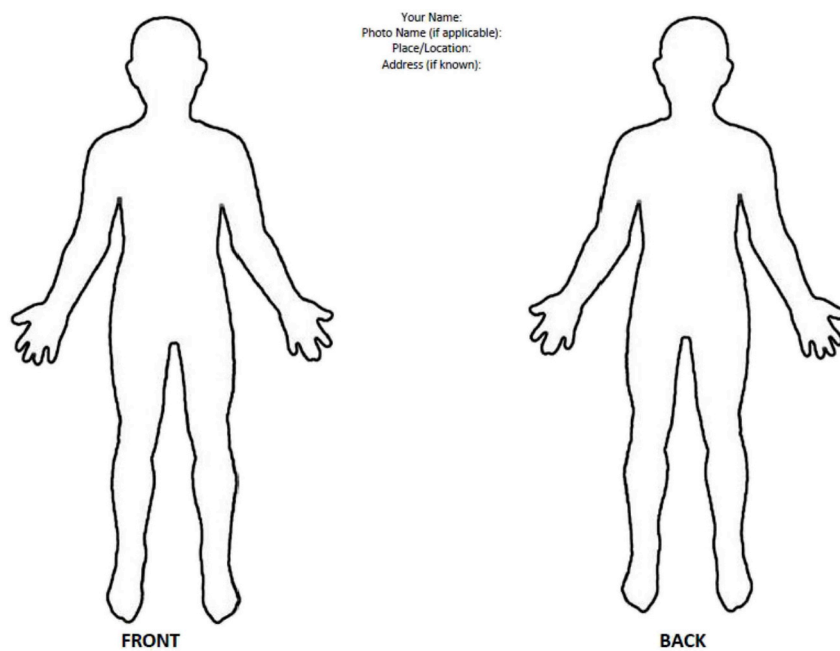


Fig. 1. X-Ray Mapping Worksheet.

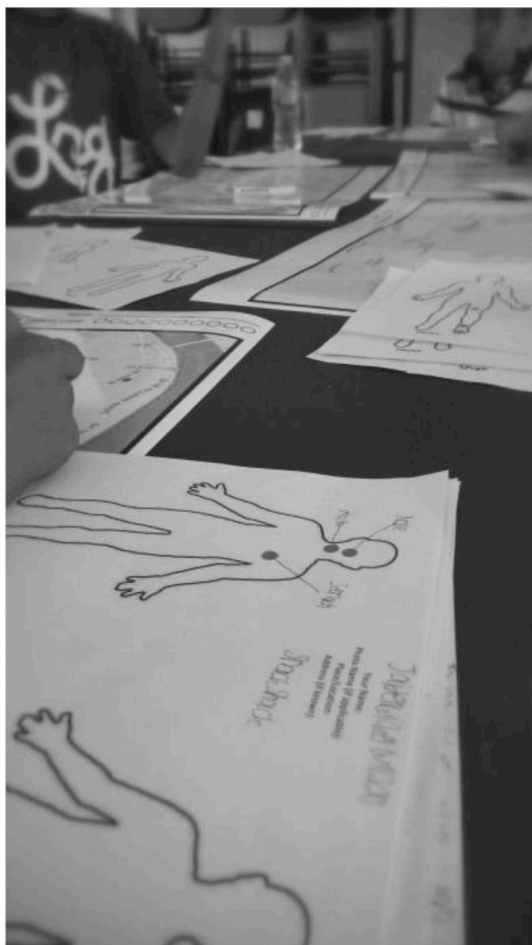


Photo 1. Participants completing X-Ray maps.

2.4.4. X-Ray Mapping findings

In the end, what participants generated were place-specific representations of perceived place-embodiment effects that are

physiologically-specific. In other words, they created maps of place-embodiment that are simultaneously physiologic and geographic in nature—their “geographies of embodiment”.

Tables 1 and 2 summarize the overall adult and youth place-embodiment data, as well as domain-specific adult and youth place-embodiment data. The different number of adult versus youth participants with complete data limits the ability to make meaningful interpretations of count differences here. However, these data do provide a general sense of adults' and youths' positive/negative perceptions within each place-domain. The tables show the total number of body areas identified by participants as being affected by places within each place-domain, “Total Body Areas Affected”. For example, adult participants indicated that 5 different body areas are affected within their *Home* place-domain (1 positively, and all 5 negatively). Each body area could be affected in more than one way, thus the total number of indicated body effects across body areas is shown as “Total Body Effects” below. Using the same example, adults identified 11 total body effects across the 5 body areas they indicated were affected by their *Home* place-domain. Overall, youth indicated that their daily places positively and/or negatively affected 20 different body areas across the 5 place-domains, while adults identified 12 body areas. Among all body areas affected, youth reported 85% (17/20) being affected positively and 80% (16/20) being affected negatively across the place-domains. These numbers were 58% (7/12) and 83% (10/12), respectively, for the adults. Among all body-effects identified across the 5 place-domains, youth and parents indicated 39% and 32%, respectively, as being positive. The *Neighborhood* place-domain had the most identified body-effects for both adults (42) and youth (44), with both groups reporting more negative effects than positive effects (74% and 64% negative). Among the 5 place-domains, the *Home* place-domain was the most “negative” overall, with adults indicating 91% of identified body-effects as negative and youth identifying fully 100% of body-effects as such. The *Transition* place-domain was similarly identified as having predominantly negative body-effects (92% and 80% for adults and youth, respectively). The *Leisure/Social* place-domain was the most positive overall, with 71% of body-effects indicated as positive for adults and 94% indicated as positive for youth.

Tables 3 and 4 summarize intergenerational perceptual differences of place-embodiment body effects by place-domain. While the value of direct comparison is limited here, these data illustrate the range and

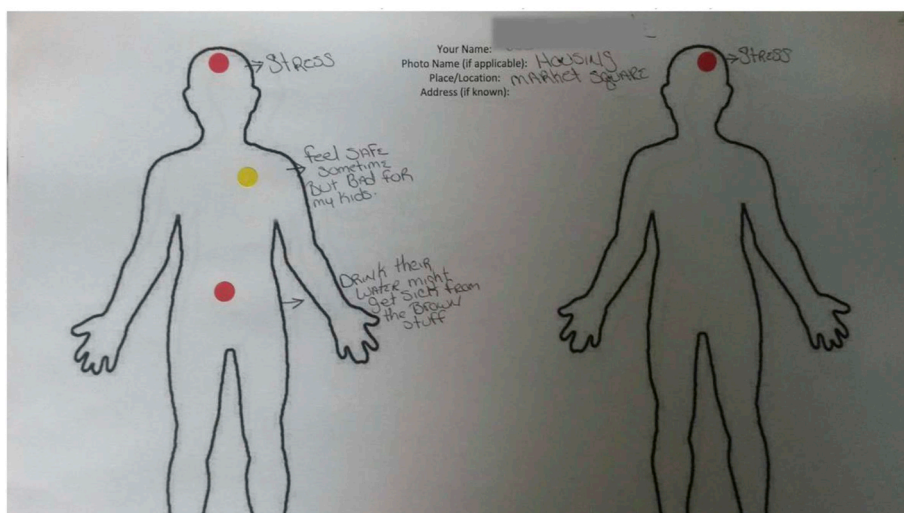


Fig. 2. Example of a Completed X-Ray Map. Figure 2: X-Ray Map representing perceptions of place-embodiment related to housing conditions (Adult Participant D).

variation of body areas reported as being affected within each among adults and youth, respectively. Perceived positive body-effects are represented in the column headed by “+”, while perceived negative body-effects are represented in the column headed “-“. For both adults and youth, the body area most identified as being affected by their places was the brain. For the adults, heart, legs, stomach, and eyes round out the top 5 body areas affected by their daily places across the 5 place-domains; for youth, legs, feet, eyes, and stomach complete the top 5 most affected body areas. Adults identified heart, brain, and legs as the most positively affected body areas, and brain, heart, and eyes as the most negatively affected. Youth identified brain, legs, and stomach as the most positively affected body areas, and brain, legs, and feet as the most negatively affected.

Fig. 3 and 4 graphically represent adult and youth “geographies of embodiment”. The 5 place-domains are represented by the color-coded symbols and embodiment circles. The size of the circles corresponds to the number of times a specific body area was identified as being affected, either positively or negatively, within that particular place-domain. Green represents the “Home” place-domain; blue represents the “Neighborhood” place-domain; purple represents the “School/Work” place-domain; grey represents the “Leisure/Social” place-domain; and orange represents the “Transition” place-domain.

Fig. 5 and Fig. 6 show adult and youth place-embodiment perceptions specifically for the *Neighborhood* place-domain, with representation of positive and negative body-effects. Here, indicated positive effects are represented in green, with negative effects represented in red.

Fig. 7 and Fig. 8 show adult and youth “geographies of embodiment” as mapped through the web-based community mapping platform, *Local Ground*. The maps are participants’ spatially-specific perceptions of place-embodiment across the 5 place-domains—maps of embodiment that are simultaneously physiologic and geographic in nature. The black polygon is the participants’ residential census tract, while the black marker is the location of their housing community. Youth embodiment locations are based on 50 completed X-Ray Maps, while adult locations are based on 26 completed X-Ray Maps. Youth had 20 unique reports of positive place-embodiment and 31 unique reports of negative place-embodiment across the 5 place-domains, with

some youth reporting effects for the same location (e.g. their housing community). Adults had 13 unique reports of positive place-embodiment and 16 unique reports of negative place-embodiment across the 5 place-domains. Overall, 25 out of 51 (49%) youth reports of place-embodiment were for places spatially outside of their residential census tract; for adults, 18 out 29 (62%) were spatially outside of their residential census tract. Among youth, 15 of 20 (75%) positive place-embodiment locations were outside of their residential census tract, while 21 of 31 (66%) negative place-embodiment locations were inside. Among adult and youth participants, 22 of 33 (67%) of positive place-embodiment locations were spatially located outside of their residential census tract. Again, while the value of direct comparison of numbers between adults and youth is limited here, they do well to illustrate how experiences of embodiment can vary both spatially and perceptually, and provide an overall sense of positive/negative spaces of embodiment across and within generations.

3. Discussion

Adult and youth participants’ “geographies of embodiment” varied, as did their perceptions of place-embodiment. Within this variation, a few prominent take-away observations are particularly worth noting. First, while there was some expected overlap in both positive and negative place-embodiment spatial locations between adults and youth, most of this occurred for locations within their residential census tract—namely their housing community and the community recreation center. Beyond their census tract, overlap between adult and youth place-embodiment locations was limited to a retail shopping plaza just outside census tract bounds. Within these overlapping places of embodiment, however, perceptions of embodiment in regard to the specific experiences/exposures (i.e. place attributes) identified as affecting their bodies and how (i.e. which body areas) were markedly different between adults and youth. For example within the “Home” place-domain, both adults and youth reported place-embodiment effects related to their physical home environment and the quality of housing management services. On one hand, adults identified place-embodiment effects related to the quality of their tap water (i.e. “brown stuff” in it),

Text box 1

X-Ray Map Place-Embodiment Narrative Example

“Market Square people are very stressing, unhealthy, and annoying due to all of the nonsense, partying and loud talking at night. Also some of the people make my stomach hurt by the things they do and say.” **Youth Participant G.**

Table 1

Adult Place-Embodiment Summary. *Although adults identified places of work during this project, they did not complete any X-Ray maps detailing their related place-embodiment perceptions.

Adult Place-Embodiment Perceptions by Place-Domain						
Summary Indicator	HOME	NEIGHBORHOOD	SCHOOL/WORK*	LEISURE/SOCIAL	TRANSITION	OVERALL
Total Body Areas Affected	5	9	-	7	8	12
Total Body Effects	11	42	-	21	13	87
Positively Affected Body Areas	1 (20%)	4 (44%)	-	7 (100%)	1 (13%)	7 (58%)
Total Positive Effects	1 (9%)	11 (26%)	-	15 (71%)	1 (8%)	28 (32%)
Negatively Affected Body Areas	5 (100%)	9 (100%)	-	3 (43%)	8 (100%)	10 (83%)
Total Negative Effects	10 (91%)	31 (74%)	-	6 (29%)	12 (92%)	59 (68%)

holes in their apartment unit walls and ceilings, and regularly dysfunctional washers and dryers, for example. Youth on the other hand reported place-embodiment perceptions related to distressed building hallways, deteriorating community greenspace, and tears in apartment unit carpeting (which management “fixes” with duct tape), for example. Moreover, only youth reported place-embodiment effects related to the social environment of their housing community (e.g. Text Box 1), while adult perceptions of place-embodiment were limited exclusively to physical attributes. These variations highlight the heterogeneity of “place” as experienced by people who jointly encounter the same physical and social spaces on a regular basis—what is salient to some might not be so for others. As noted previously, research indicates the importance of engaging subjective measures of place and health (Barrington et al., 2014; Lin and Moudon, 2010; Park et al., 2015; van Deurzen et al., 2016; Weden et al., 2008; Wen et al., 2006). Moreover, there is a growing body of work focused on age- and aging-related experiences and perceptions of place (Fang et al., 2016; Hand et al., 2018; John and Gunter, 2016; Milton et al., 2015; Tong et al., 2016). This scholarship demonstrates the importance of taking life-stage and generationally-specific approaches within place-health inquiry, while simultaneously exemplifying the value of mixed and participatory methods in doing so. This work could thus prove instructive for place-embodiment research going forward, illustrating how we might more appropriately conceptualize and accommodate resident agency within our efforts to uncover processes and spatial patterns of their place-based embodiment experiences that are inextricably linked to life-stage. Findings in the present study suggest the importance of taking inter-generational approaches when possible—more actively involving both youth and adults so as to better elucidate potential age, generation, and life-stage considerations for place-embodiment over the lifecycle.

Second, 49% of youth place-embodiment reports and 62% of adult place-embodiment reports were for places spatially located outside of their residential census tract. Moreover, an overwhelming majority of positive place-embodiment effects were reported for locations outside of their census tract. This was especially true for youth, with 75% of positive place-embodiment locations outside their census tract, contrasted with 66% of negative place-embodiment locations inside. These overall patterns lend further support to increasing calls to move away from administratively defined/bound and static notions of place, and towards more dynamic, relational, and activity space oriented approaches (Browning and Soller, 2014; Steven Cummins et al., 2007; Cutchin et al., 2011; Jones and Pebley, 2014; Matthews, 2011;

Perchoux et al., 2013; Rainham et al., 2010). The results for this present study, indicate that traditional approaches to assessing relationships between place, place-embodiment, and health are inadequate—namely, those approaches which arbitrarily delimit notions of “neighborhood” using, experientially speaking, imaginary administrative lines, and those which fail to account for where people actually go beyond those imaginary lines. Anchoring the geographies of embodiment concept within a placescape approach allowed for the discernment of spatially-specific patterns of place experiences and exposures, patterns which payed no regard to the imaginary lines bounding participants’ area of residence (Petteway, 2017). This approach accordingly enabled examination of participants’ geographies of embodiment in relation to the geography of census tracts, highlighting shortcomings of the latter in regard to its analytic utility in place-embodiment research. Understanding gained from these findings can accordingly enhance future work within this community aimed at developing appropriate quantitative metrics to examine place-embodiment.

A third and related takeaway, as noticeable in their embodiment maps, is that the majority of the participants’ residential census tract, spatially and experientially speaking, has no bearing on their daily lived and embodied place experiences. Indeed, participants’ place-embodiment data revealed a distinct pattern of clusters of important day-to-day place locations, some of which were spatially distributed within only a small portion of their census tract, with others distributed outside of their census tract entirely. These clusters constitute what might be considered spatial “nodes” within a local or regional network of place-based opportunities, resources, and risks (Cummins et al., 2007), and draw attention to the importance of participants’ daily mobility patterns and activity spaces in shaping place-based experiences/exposures. Participants’ work renders clear the multi-nodal nature of place, and the extent to which nodes can and do stretch the bounds of “place” far beyond the imaginary lines of administrative polygons. Moreover, findings provide insight regarding the social and spatial structure of participants’ concurrent place attachments and affinities—in part revealing their “spatially polygamous” relationship to “place”. The notion of “spatial polygamy” (Matthews, 2011; Matthews and Yang, 2013) suggests that individuals have meaningful relationships with multiple nested and non-nested places simultaneously, and these relationships tend to be both an element of, and structured by, present and historic geographic and social contexts. Thus, to appropriately conceptualize and measure place, we must account for person-centered spatial configurations of multiple concurrent place attachments, as well as the

Table 2

Youth Place-Embodiment Summary.

Youth Place-Embodiment Perceptions by Place-Domain						
Summary Indicator	HOME	NEIGHBORHOOD	SCHOOL/WORK	LEISURE/SOCIAL	TRANSITION	OVERALL
Total Body Areas Affected	10	16	6	10	9	20
Total Body Effects	10	44	11	17	25	107
Positively Affected Body Areas	0	11 (69%)	4 (67%)	9 (90%)	5 (56%)	17 (85%)
Total Positive Effects	0	16 (36%)	5 (45%)	16 (94%)	5 (20%)	42 (39%)
Negatively Affected Body Areas	10 (100%)	11 (69%)	4 (67%)	1 (10%)	8 (89%)	16 (80%)
Total Negative Effects	10 (100%)	28 (64%)	6 (55%)	1 (6%)	20 (80%)	65 (61%)

Table 3
Youth Place-Embodiment: Positive/negative body effect perceptions by Place-Domain.

YOUTH X-Ray Mapping: Place-Embodiment Body Effect Perceptions by Place-Domain												
Affected Body Area	HOME		NEIGHBORHOOD		SCHOOL		LEISURE/SOCIAL		TRANSITION		OVERALL	
	+	-	+	-	+	-	+	-	+	-	+	-
Brain	0	1	2	10	2	2	5	0	0	5	9	18
Brain/Head	0	1	1	2	0	0	1	0	1	1	3	4
Mind	0	0	0	1	0	0	0	0	0	0	0	1
Head	0	0	0	1	0	0	0	0	0	0	0	1
Eyes	0	0	0	2	0	0	3	0	0	3	3	5
Ears	0	1	1	0	0	0	0	0	0	0	1	1
Nose	0	1	1	1	0	0	0	0	0	0	1	2
Mouth	0	0	1	0	1	0	0	0	0	0	2	0
Heart	0	1	1	1	0	0	2	0	0	0	3	2
Lungs	0	0	0	0	0	0	0	0	0	0	0	0
Stomach	0	1	3	0	0	1	1	0	0	0	4	2
Back	0	0	0	2	0	0	1	0	0	2	1	4
Arms	0	0	1	0	0	0	1	0	0	0	2	0
Hands	0	0	0	0	1	0	0	0	0	0	1	0
Butt	0	1	0	0	0	0	1	0	0	0	1	1
Legs	0	1	3	4	0	0	1	0	1	4	5	9
Knees	0	0	0	0	0	0	0	1	1	0	1	1
Shins	0	1	1	0	0	1	0	0	1	1	2	3
Feet	0	1	1	2	1	2	0	0	1	3	3	8
Stress	0	0	0	2	0	0	0	0	0	1	0	3
Total	0	10	16	28	5	6	16	1	5	20	42	65

forces which have historically shaped and presently drive/maintain such configurations.

For the work presented here, clear spatial nodes and relationships emerged as participants mapped their geographies of embodiment—geographies bearing little resemblance to the geography of their census tract. Indeed, their geographies of embodiment illustrate the importance of activity space approaches to studying place. For the present study, as illustrated in Figs. 7 and 8, operationalizing measures of “place” context based generically on participants’ entire residential census tract would be inappropriate in itself. To then focus *only* on their residential census tract would only further distort assessment of their real “place”. Failing to account for participants’ multi-nodal “place” (and its actual spatial bounds) would increase risk for the misspecification of place-effects, an increasing concern within the field (Jones and Pebley, 2014; Kwan, 2012; Diez Roux, 2007; Spielman and Yoo, 2009). Work by Inagami et al. (2007), for example, found that residents of disadvantaged neighborhoods had better self-reported health as they spent more time outside their census tract of residence. The approach taken here in engaging the notion of geographies of embodiment—rooted in participatory activity space mapping—can help to better distinguish and analytically appraise salient places, which in turn may help allay concerns over misspecification and more aptly

capture people’s experiences of place and place-embodiment.

Fourth, spatially locating perceptions of embodiment as related to specific physical and social environmental factors allowed participants to tell a story of place-embodiment within which potential pathways of embodiment can more readily be discerned (Krieger, 2001). These pathways—the processes and mechanisms through which current and historic societal arrangements of power, privilege, and opportunity shape and organize contexts and conditions of place embodiment—are seldom (if ever) explicated within place-health research. Given the spatial and physiologic range of embodiment effects reported, there is implication of a broad range of local/regional policies, processes, and practices that shape daily living conditions, experiences, and exposures that become physically embodied by residents. This is in stark contrast to much place-embodiment work to date that has both failed to identify and spatially locate specific place attributes implicated in place-embodiment, and foregone attempts to uncover elements of the local context (i.e. pertinent to the samples’ place-embodiment prospects) that are on or might constitute potential pathways of embodiment. As articulated by Krieger (2001), embodiment and pathways of embodiment should be understood in light of and cannot be divorced from notions of agency and accountability. By identifying specific attributes/aspects of place contexts and their relations to embodiment, and by elucidating a

Table 4
Adult Place-Embodiment: Positive/negative body effect perceptions by Place-Domain.

ADULT X-Ray Mapping: Place-Embodiment Body Effect Perceptions by Place-Domain												
Affected Body Area	HOME		NEIGHBORHOOD		WORK		LEISURE/SOCIAL		TRANSITION		OVERALL	
	+	-	+	-	+	-	+	-	+	-	+	-
Brain	0	4	4	8	0	0	3	1	0	2	7	15
Brain/Head	0	0	0	0	0	0	0	0	0	0	0	0
Mind	0	0	0	0	0	0	0	0	0	0	0	0
Head	0	0	0	0	0	0	0	0	0	0	0	0
Eyes	0	0	0	5	0	0	0	0	0	2	0	7
Ears	0	0	0	0	0	0	0	0	0	0	0	0
Nose	0	0	0	2	0	0	0	0	0	1	0	3
Mouth	0	0	0	0	0	0	0	0	0	0	0	0
Heart	1	2	2	6	0	0	5	2	1	2	9	12
Lungs	0	0	0	2	0	0	1	0	0	1	1	3
Stomach	0	2	2	3	0	0	1	0	0	1	3	6
Back	0	1	0	0	0	0	1	0	0	0	1	1
Arms	0	0	0	0	0	0	1	0	0	0	1	0
Hands	0	0	0	1	0	0	0	0	0	0	0	1
Butt	0	0	0	0	0	0	0	0	0	0	0	0
Legs	0	1	3	1	0	0	3	3	0	1	6	6
Knees	0	0	0	0	0	0	0	0	0	0	0	0
Shins	0	0	0	0	0	0	0	0	0	0	0	0
Feet	0	0	0	3	0	0	0	0	0	2	0	5
Stress	0	0	0	0	0	0	0	0	0	0	0	0
Total	1	10	11	31	0	0	15	6	1	12	28	59

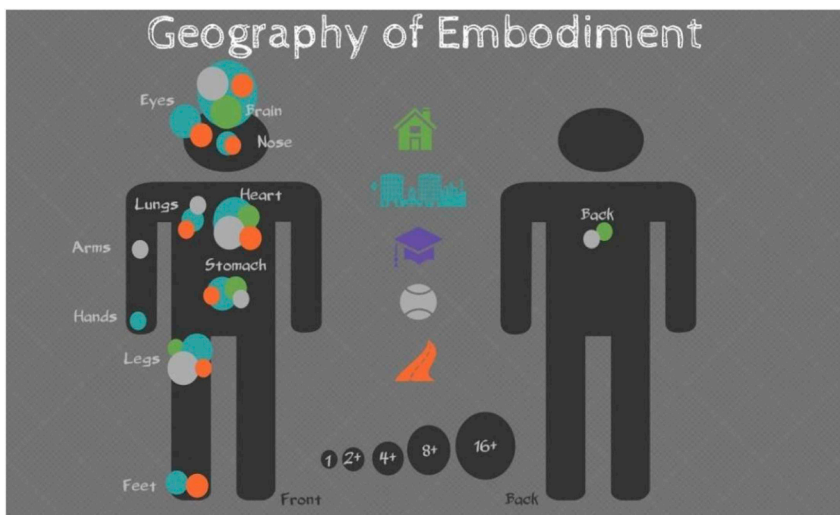


Fig. 3. Adult “Geography of Embodiment” Summary. Adult Geography of Embodiment. Green represents the “Home” place-domain; Blue represents “Neighborhood”; Purple represents “School/Work”; Grey represents “Leisure/Social”; and Orange represents “Transition”. The size of the circle reflects the number of times a specific body area was identified as being affected. This figure includes both positive and negative place-embodiment perceptions. (For interpretation of the references to color in this figure legend, the reader is referred to the Web version of this article.)

more robust spectrum of potential social and political processes and practices that shape place-embodiment patterns, we improve our ability to answer fundamental questions in regards to: 1) who and what shapes/determines distributions and patterns of underlying health opportunities, exposures, and risks in these locally experienced spaces of embodiment; 2) what these distributions and patterns can tell us about agency and accountability at the local and regional level; and 3) what is at stake in, and what is the value of, telling spatially- and jurisdictionally-specific stories of embodiment. The approach taken to the work discussed here allows for these questions to be meaningfully engaged within participants’ daily place contexts.

4. Conclusion and future direction

The aim of the work presented here was to highlight a new methodology—X-Ray Mapping—and introduce “geographies of embodiment” as an opportunity to enhance place-health research efforts going forward. This early-stage work makes a unique and rare qualitative contribution to the growing place-embodiment literature, and suggests it is an area that warrants further development and continued investigation. X-Ray Mapping as used here to generate “geographies of embodiment” requires some form of spatial mapping/geolocation—as this notion dually maps body locations *and* the multiple and varying geographic locations perceived to affect those body locations. However, X-Ray Mapping can be (and has been) used without other visual or

mapping methods, e.g. in [Ruglis \(2011\)](#) work exploring how processes of schooling (e.g. social environment, physical environment, high stakes testing) affect students’ bodies. We believe X-Ray Mapping alone is beneficial in and of itself for place-embodiment work, e.g. using it to elucidate perceptions of embodiment for singular locations/places, as has been the case for “body mapping” in other fields. However, we believe it holds the most value when used to examine place-embodiment across multiple spatial locations, thus requiring other methods (here, activity space mapping to identify and locate daily places, and participatory GIS via the web-based mapping platform to formally geolocate them).

Anchored in X-Ray Mapping, the geographies of embodiment concept is responsive to existing limitations within place-embodiment research, offering a way to reframe and re-approach our work. It is not only capable of revealing general patterns of place-embodiment within a particular community, but can reveal specific place attributes within those patterns that directly or indirectly implicate local policies and practices—i.e. potential pathways of embodiment—that shape daily social and physical environments. Accordingly, the geographies of embodiment concept can improve efforts to uncover place-embodiment processes and mechanisms, and better inform appropriate and timely action, be it programmatic interventions or changes in policy and practice—especially that which can be realized within the local contexts where place-embodiment research unfolds. For example, applying the geographies of embodiment concept and coupling the X-Ray

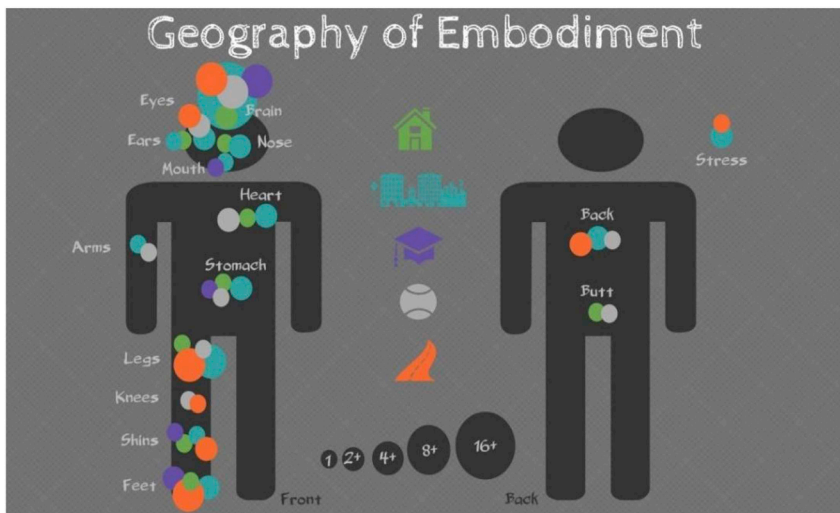


Fig. 4. Youth “Geography of Embodiment” Summary. Youth Geography of Embodiment. Green represents the “Home” place-domain; Blue represents “Neighborhood”; Purple represents “School/Work”; Grey represents “Leisure/Social”; and Orange represents “Transition”. The size of the circle reflects the number of times a specific body area was identified as being affected. This figure includes both positive and negative place-embodiment perceptions. (For interpretation of the references to color in this figure legend, the reader is referred to the Web version of this article.)

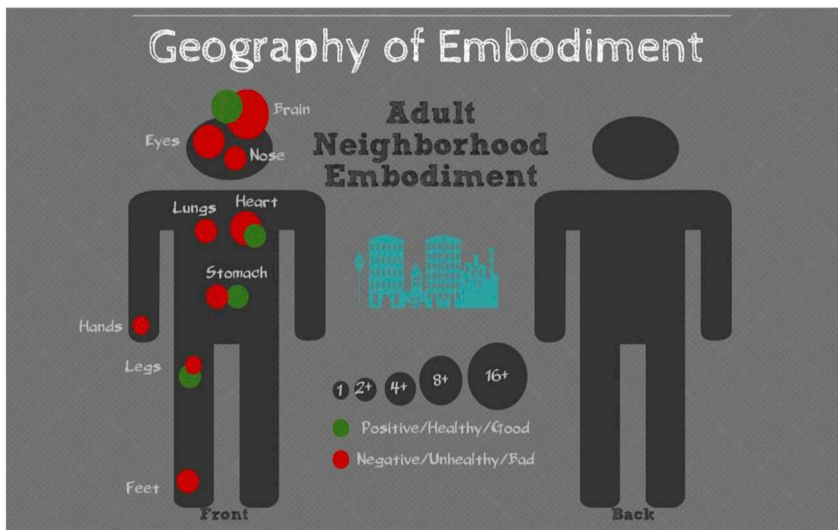


Fig. 5. Adult Neighborhood “Geography of Embodiment”. Adult “Neighborhood” Geography of Embodiment. Green represents perceived positive/health/good place-embodiment effects; Red represents perceived negative/unhealthy/bad place-embodiment effects. The size of the circle reflects the number of times a specific body area was identified as being affected. (For interpretation of the references to color in this figure legend, the reader is referred to the Web version of this article.)

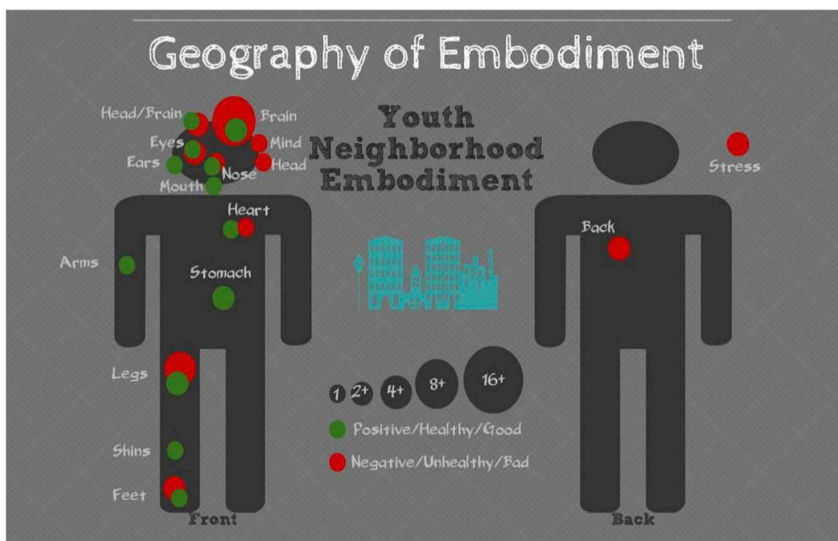


Fig. 6. Youth Neighborhood “Geography of Embodiment”. Youth “Neighborhood” Geography of Embodiment. Green represents perceived positive/health/good place-embodiment effects; Red represents perceived negative/unhealthy/bad place-embodiment effects. The size of the circle reflects the number of times a specific body area was identified as being affected. (For interpretation of the references to color in this figure legend, the reader is referred to the Web version of this article.)

Positive Place-Embodiment (Left) and Negative Place-Embodiment (Right)

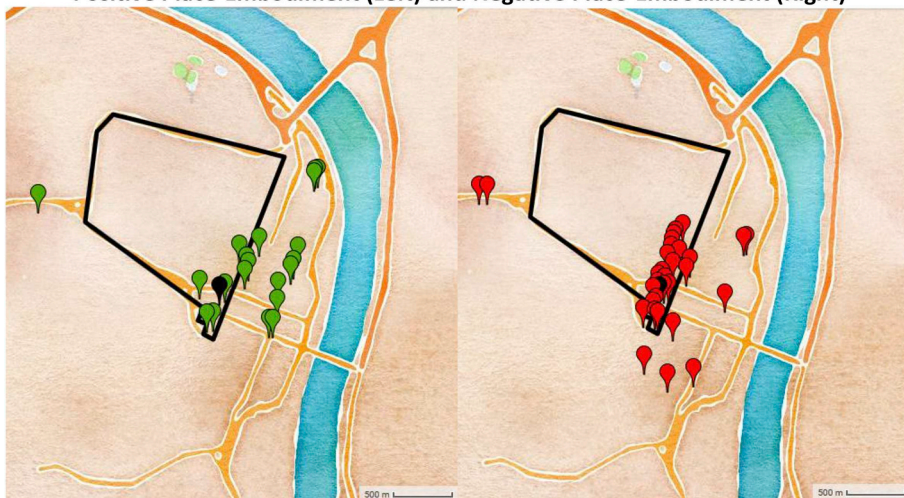


Fig. 7. Youth Geography of Embodiment: Positive Place-Embodiment (Left) and Negative Place-Embodiment (Right). Youth reported perceptions of place-embodiment for specific locations they encounter. Green Markers represent locations youth perceived as having a positive body-effect, while represent Red Markers represent the opposite. The black polygon is an outline of the census tract in which the participants' housing community is located. The Black Marker is their housing location. (For interpretation of the references to color in this figure legend, the reader is referred to the Web version of this article.)

Mapping methodology with biometric place-embodiment work could allow for assessing potential compatibility and convergence of objective and subjective place-embodiment patterns. Additionally, taking such a

dual approach would enable assessment of the political utility, local social value, and action potential of various forms and representations of place-embodiment knowledge and data. Moreover, there is

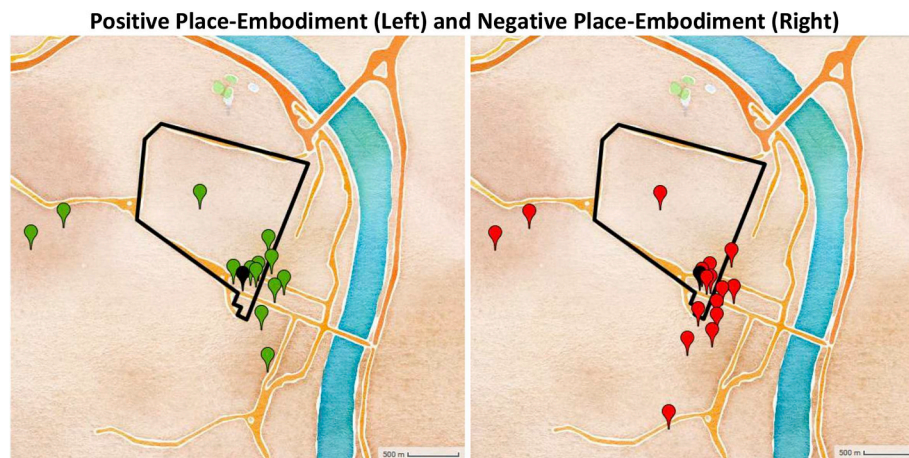


Fig. 8. Adult Geography of Embodiment: Positive Place-Embodiment (Left) and Negative Place-Embodiment (Right). Adult reported perceptions of place-embodiment for specific locations they encounter. Green Markers represent locations adults perceived as having a positive body-effect, while Red Markers represent the opposite. The black polygon is an outline of the census tract in which the participants' housing community is located. The Black Marker is their housing location. (For interpretation of the references to color in this figure legend, the reader is referred to the Web version of this article.)

increasing movement towards place-based initiatives and strategies in public health, city planning, and community development (FRBSF, 2010; Fukuzawa and Karnas, 2015; HOPE, 2015; HUD, 2013a-c; Jutte et al., 2011; NCHE, 2017; Pastor and Morello-Frosch, 2014; TCE, 2017). The notion of geographies of embodiment could represent a potentially valuable conceptual and analytical framework to inform the design, development, and evaluation of place-based efforts in current and future practice. It might also complement the use of other metrics aimed at assessing “geographies of opportunity” (Briggs, 2007; Galster and Killen, 1995; Osypuk and Acevedo-Garcia, 2010), e.g. the Child Opportunity Index (Acevedo-Garcia et al., 2014), as geographies of embodiment might reflect and extend this notion as an expression and consequence of local and regional policy decisions that spatially sort place-embodiment experiences.

The X-Ray Mapping methodology, and other participatory inter-generational approaches that draw upon peoples' knowledge of local contexts and their lived and embodied experience of “place”, could represent and encourage novel approaches to community assessment for public health strategizing and comprehensive city planning. Also, taking advantage of the increasing availability and utility of ICTs could further enhance the value and extend the reach of methodologies like X-Ray Mapping. The research presented here made use of a web-based multimedia-enabled community mapping platform, thus enabling participants' geographies of embodiment to be digitally mapped and readily shared and distributed. Such ICTs, appropriately designed and deployed (Avgerou, 2010; Burrell & Toyama, 2009; Dearden, 2012; D'Ignazio et al., 2014.; Diamond, 2010; Pfister and Godana, 2012), raise the prospect of population-wide assessment of place, embodiment, and health relationships in both research and practice, e.g. via crowdsourcing approaches (Kamel Boulos et al., 2011). And while we did not examine place-embodiment effects/perceptions over time in the present study, we believe it could be instructive methodologically and procedurally for how to do so. For example, using the X-ray Mapping method and geographies of embodiment concept to explore place-embodiment with multiple generations longitudinally, or adding an X-Ray Mapping component to longitudinal quantitative work examining place and health (e.g. work from Gustafsson et al., 2014). We believe such approaches present opportunities to not only improve the quality and depth of place-embodiment research, but also to create a more inclusive, more humanized field of inquiry. All in all, the work presented here suggests a range a possibilities to enhance place-health and place-embodiment research and practice going forward.

IRB

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References

- Acevedo-Garcia, D., McArdle, N., Hardy, E.F., Crisan, U.I., Romano, B., Norris, D., et al., 2014. The child opportunity index: improving collaboration between community development and public health. *Health Aff.* 33 (11), 1948–1957. <https://doi.org/10.1377/hlthaff.2014.0679>.
- Avgerou, C., 2010. Discourses on ICT and development. *Inf. Technol. Int. Dev.* 6 (3), 1–18.
- Barrington, W.E., Stafford, M., Hamer, M., Beresford, S.A.A., Koepsell, T., Steptoe, A., 2014. Neighborhood socioeconomic deprivation, perceived neighborhood factors, and cortisol responses to induced stress among healthy adults. *Health Place* 27, 120–126. <https://doi.org/10.1016/j.healthplace.2014.02.001>.
- Bernard, P., Charafeddine, R., Frohlich, K.L., Daniel, M., Kestens, Y., Potvin, L., 2007. Health inequalities and place: a theoretical conception of neighbourhood. *Soc. Sci. Med.* 65 (9), 1839–1852. <https://doi.org/10.1016/j.socscimed.2007.05.037>.
- Brenner, A.B., Zimmerman, M.A., Bauermeister, J.A., Caldwell, C.H., 2013. Neighborhood context and perceptions of stress over time: an ecological model of neighborhood stressors and intrapersonal and interpersonal resources. *Am. J. Community Psychol.* 51 (3–4), 544–556. <https://doi.org/10.1007/s10464-013-9571-9>.
- Briggs, X. de S., 2007. More pluribus, less unum? The changing geography of race and opportunity. In: Beider, H. (Ed.), *Neighbourhood Renewal & Housing Markets*. Blackwell Publishing Ltd, Oxford, UK, pp. 63–87. <https://doi.org/10.1002/9780470757871.ch3>.
- Browning, C.R., Soller, B., 2014. Moving beyond neighborhood: activity spaces and ecological networks as contexts for youth development. *Citiescape (Washington, DC)* 16 (1), 165.
- Broyles, S.T., Staiano, A.E., Drazba, K.T., Gupta, A.K., Sothorn, M., Katzmarzyk, P.T., 2012. Elevated C-Reactive Protein in Children from Risky Neighborhoods: evidence for a Stress Pathway Linking Neighborhoods and Inflammation in Children. *PLoS One* 7 (9), e45419. <https://doi.org/10.1371/journal.pone.0045419>.
- Buron, L., Comey, J., Cunningham, M.K., Harris, L.E., Levy, D., Popkin, S.J., 2002. *HOPE VI Panel Study: Baseline Report*. pp. 283.
- Burrell, J., Toyama, K., 2009. What constitutes good ICTD research? *Inf. Technol. Int. Dev.* 5 (3), 13.
- Catalani, C., Minkler, M., 2010. Photovoice: a review of the literature in health and public health. *Health Educ. Behav.* 37 (3), 424–451. <https://doi.org/10.1177/1090198109342084>.
- Chaix, B., Merlo, J., Evans, D., Leal, C., Havard, S., 2009. Neighbourhoods in eco-epidemiologic research: delimiting personal exposure areas. A response to Riva, Gauvin, Apparicio and Brodeur. *Soc. Sci. Med.* 69 (9), 1306–1310. <https://doi.org/10.1016/j.socscimed.2009.07.018>.

- Cornwall, A., 1992. *Body Mapping in Health RRA/PRA*. RRA Notes, Issue 16. IIED London, pp. 69–76.
- Crimmins, E.M., Johnston, M., Hayward, M., Seeman, T., 2003. Age differences in allostatic load: an index of physiological dysregulation. *Exp. Gerontol.* 38 (7), 731–734. [https://doi.org/10.1016/S0531-5565\(03\)00099-8](https://doi.org/10.1016/S0531-5565(03)00099-8).
- Cummins, S., 2007. Commentary: investigating neighbourhood effects on health—avoiding the “local trap”. *Int. J. Epidemiol.* 36 (2), 355–357. <https://doi.org/10.1093/ije/dym033>.
- Cummins, Steven, Curtis, S., Diez-Roux, A.V., Macintyre, S., 2007. Understanding and representing ‘place’ in health research: a relational approach. *Soc. Sci. Med.* 65 (9), 1825–1838. <https://doi.org/10.1016/j.socscimed.2007.05.036>.
- Curtis, S., Southall, H., Congdon, P., Dodgeon, B., 2004. Area effects on health variation over the life-course: analysis of the longitudinal study sample in England using new data on area of residence in childhood. *Soc. Sci. Med.* 58 (1), 57–74. [https://doi.org/10.1016/S0277-9536\(03\)00149-7](https://doi.org/10.1016/S0277-9536(03)00149-7).
- Cutchin, M.P., 2007. The need for the “new health geography” in epidemiologic studies of environment and health. *Health Place* 13 (3), 725–742.
- Cutchin, M.P., Eschbach, K., Mair, C.A., Ju, H., Goodwin, J.S., 2011. The socio-spatial neighborhood estimation method: an approach to operationalizing the neighborhood concept. *Health Place* 17 (5), 1113–1121. <https://doi.org/10.1016/j.healthplace.2011.05.011>.
- Dearden, A., 2012. See No Evil?: Ethics in an Interventionist ICTD. ACM Press, pp. 46. <https://doi.org/10.1145/2160673.2160680>.
- Diamond, Larry, 2010. Liberation technology. *J. Democr.* 21 (3), 69–83. <https://doi.org/10.1353/jod.0.0190>.
- Diez Roux, A.V., 2004. The study of group-level factors in epidemiology: rethinking variables, study designs, and analytical approaches. *Epidemiol. Rev.* 26 (1), 104–111. <https://doi.org/10.1093/epirev/mxh006>.
- D'Ignazio, C., Warren, J., Blair, D., 2014. *The Role Of Small Data For Governance In The 21st Century*. pp. 15.
- Do, D.P., Diez Roux, A.V., Hajat, A., Auchincloss, A.H., Merkin, S.S., Ranjit, N., et al., 2011. Circadian rhythm of cortisol and neighborhood characteristics in a population-based sample: the Multi-Ethnic Study of Atherosclerosis. *Health Place* 17 (2), 625–632. <https://doi.org/10.1016/j.healthplace.2010.12.019>.
- Dorn, M., Laws, G., 1994. Social theory, body politics, and medical geography: extending kearns's invitation. *Prof. Geogr.* 46 (1), 106–110. <https://doi.org/10.1111/j.0033-0124.1994.00106.x>.
- Dyck, I., 2003. Feminism and Health Geography: twin tracks or divergent agendas? *Gend. Place Cult.* 10 (4), 361–368. <https://doi.org/10.1080/0966369032000153331>.
- Ellen, I.G., Mijanovich, T., Dillman, K.-N., 2001. Neighborhood effects on health: exploring the links and assessing the evidence. *J. Urban Aff.* 23 (3–4), 391–408.
- Fang, M.L., Woolrych, R., Sixsmith, J., Canham, S., Battersby, L., Sixsmith, A., 2016. Place-making with older persons: establishing sense-of-place through participatory community mapping workshops. *Soc. Sci. Med.* 168, 223–229. <https://doi.org/10.1016/j.socscimed.2016.07.007>.
- Fertig, A.R., Reingold, D.A., 2007. Public housing, health, and health behaviors: is there a connection? *J. Pol. Anal. Manag.* 26 (4), 831–860. <https://doi.org/10.1002/pam.20288>.
- FRBSF, 2010. *Federal reserve bank of san francisco, place-based initiatives*. Commun. Invest. 22 (1).
- Frumkin, H., 2006. The measure of place. *Am. J. Prev. Med.* 31 (6), 530–532.
- Fukuzawa, D.D., Karnas, F., 2015. Reconnecting health and housing: philanthropy's new opportunity. *Environ. Justice* 8 (3), 86–94. <https://doi.org/10.1089/env.2015.0006>.
- Galster, G.C., Killen, S.P., 1995. The geography of metropolitan opportunity: a reconnaissance and conceptual framework. *Hous. Policy Debate* 6 (1), 7–43. <https://doi.org/10.1080/10511482.1995.9521180>.
- Gastaldo, D., Magalhães, L., Carrasco, C., Davy, C., 2012. *Body-Map Storytelling as Research*. pp. 50.
- Gebreab, S.Y., Riestra, P., Gaye, A., Khan, R.J., Xu, R., Davis, A.R., et al., 2016. Perceived neighborhood problems are associated with shorter telomere length in African American women. *Psychoneuroendocrinology* 69, 90–97. <https://doi.org/10.1016/j.psyneuen.2016.03.018>.
- Geronimus, A.T., 1992. The weathering hypothesis and the health of African-American women and infants: evidence and speculations. *Ethn. Dis.* 2 (3), 207–221.
- Geronimus, Arline T., Hicken, M., Keene, D., Bound, J., 2006. “Weathering” and age patterns of allostatic load scores among blacks and whites in the United States. *Am. J. Public Health* 96 (5), 826–833. <https://doi.org/10.2105/AJPH.2004.060749>.
- Geronimus, Arline T., Pearson, J.A., Linnenbringer, E., Schulz, A.J., Reyes, A.G., Epel, E.S., et al., 2015. Race/ethnicity, poverty, urban stressors and telomere length in a Detroit community-based sample. *J. Health Soc. Behav.* 56 (2), 199–224. <https://doi.org/10.1177/0022146515582100>.
- Goldman-Mellor, S., Hamer, M., Steptoe, A., 2012. Early-life stress and recurrent psychological distress over the life-course predict divergent cortisol reactivity patterns in adulthood. *Psychoneuroendocrinology* 37 (11), 1755–1768. <https://doi.org/10.1016/j.psyneuen.2012.03.010>.
- Gustafsson, P.E., San Sebastian, M., Janlert, U., Theorell, T., Westerlund, H., Hammarström, A., 2014. Life-course accumulation of neighborhood disadvantage and allostatic load: empirical integration of three social determinants of health frameworks. *Am. J. Public Health* 104 (5), 904–910.
- Guthman, J., Mansfield, B., 2013. The implications of environmental epigenetics: a new direction for geographic inquiry on health, space, and nature-society relations. *Prog. Hum. Geogr.* 37 (4), 486–504. <https://doi.org/10.1177/0309132512463258>.
- Hall, E., 2000. “Blood, brain and bones”: taking the body seriously in the geography of health and impairment. *Area* 32 (1), 21–29. <https://doi.org/10.1111/j.1475-4762.2000.tb00111.x>.
- Hand, C.L., Rudman, D.L., Huot, S., Gilliland, J.A., Pack, R.L., 2018. Toward understanding person–place transactions in neighborhoods: a qualitative-participatory geospatial approach. *Gerontol.* 58 (1), 89–100. <https://doi.org/10.1093/geront/gnx064>.
- Haraway, D., 1988. Situated knowledges: the science question in feminism and the privilege of partial perspective. *Fem. Stud.* 14 (3), 575–599. <https://doi.org/10.2307/3178066>.
- Harper, J., 2004. Breathless in Houston: a political ecology of health approach to understanding environmental health concerns. *Med. Anthropol.* 23 (4), 295–326. <https://doi.org/10.1080/01459740490513521>.
- Harris, L.E., Kaye, D.R., 2004. *How Are HOPE VI Families Faring?* Brief No. 5, Metropolitan Housing and Communities. Urban Institute.
- HOPE SF (2015). <http://hope-sf.org/about.php>, accessed 9/30/2015.
- Howell, E., Harris, L.E., Popkin, S.J., 2005. The health status of HOPE VI public housing residents. *J. Health Care Poor Underserved* 16 (2), 273–285. <https://doi.org/10.1353/hpu.2005.0036>.
- HUD, 2013a. HUD Choice Neighborhoods Program Site. http://portal.hud.gov/hudportal/HUD?src=/program_offices/public_indian_housing/programs/ph/cn, Accessed date: 27 February 2013.
- HUD, 2013b. HUD Partnership for Sustainable Communities Program Site. <http://www.sustainablecommunities.gov/aboutUs.html>, Accessed date: 27 February 2013.
- HUD, 2013c. HUD Sustainable Communities Regional Planning Program Site. http://portal.hud.gov/hudportal/HUD?src=/program_offices/sustainable_housing_communities/sustainable_communities_regional_planning_grants, Accessed date: 27 February 2013.
- Inagami, S., Cohen, D.A., Finch, B.K., 2007. Non-residential neighborhood exposures suppress neighborhood effects on self-rated health. *Soc. Sci. Med.* 65 (8), 1779–1791. <https://doi.org/10.1016/j.socscimed.2007.05.051>.
- Jackson, P., Neely, A.H., 2015. Triangulating health: toward a practice of a political ecology of health. *Prog. Hum. Geogr.* 39 (1), 47–64. <https://doi.org/10.1177/0309132513518832>.
- John, D.H., Gunter, K., 2016. engAGE in community: using mixed methods to mobilize older people to elucidate the age-friendly attributes of urban and rural places. *J. Appl. Gerontol.* 35 (10), 1095–1120. <https://doi.org/10.1177/0733464814566679>.
- Jones, M., Pebley, A.R., 2014. Redefining neighborhoods using common destinations: social characteristics of activity spaces and home census tracts compared. *Demography* 51 (3), 727–752. <https://doi.org/10.1007/s13524-014-0283-z>.
- Jutte, D.P., LeWinn, K.Z., Hutson, M.A., Dare, R., Falk, J., 2011. Bringing researchers and community developers together to revitalize a public housing project and improve health. *Health Aff.* 30 (11), 2072–2078. <https://doi.org/10.1377/hlthaff.2011.0701>.
- Kamel Boulos, M.N., Resch, B., Crowley, D.N., Breslin, J.G., Sohn, G., Burtner, R., et al., 2011. Crowdsourcing, citizen sensing and sensor web technologies for public and environmental health surveillance and crisis management: trends, OGC standards and application examples. *Int. J. Health Geogr.* 10 (1), 67. <https://doi.org/10.1186/1476-072X-10-67>.
- Katz, C., 2001. Vagabond capitalism and the necessity of social reproduction. *Antipode* 33 (4), 709–728. <https://doi.org/10.1111/1467-8330.00207>.
- Kearns, R.A., 1997. Narrative and metaphor in health geographies. *Prog. Hum. Geogr.* 21 (2), 269–277. <https://doi.org/10.1191/03091329762099067>.
- Keene, D.E., Geronimus, A.T., 2011. “Weathering” HOPE VI: the importance of evaluating the population health impact of public housing demolition and displacement. *J. Urban Health* 88 (3), 417–435. <https://doi.org/10.1007/s11524-011-9582-5>.
- Keith, M.M., Brophy, J.T., 2004. Participatory mapping of occupational hazards and disease among asbestos-exposed workers from a foundry and insulation complex in Canada. *Int. J. Occup. Environ. Health* 10 (2), 144–153. <https://doi.org/10.1179/oeh.2004.10.2.144>.
- King, B., 2010. Political ecologies of health. *Prog. Hum. Geogr.* 34 (1), 38–55. <https://doi.org/10.1177/0309132509338642>.
- Krieger, Nancy, 1994. Epidemiology and the web of causation: has anyone seen the spider? *Soc. Sci. Med.* 39 (7), 887–903. [https://doi.org/10.1016/0277-9536\(94\)90202-X](https://doi.org/10.1016/0277-9536(94)90202-X).
- Krieger, Nancy, 2001. Theories for social epidemiology in the 21st century: an ecosocial perspective. *Int. J. Epidemiol.* 30 (4), 668–677. <https://doi.org/10.1093/ije/30.4.668>.
- Krieger, N., 2005. Embodiment: a conceptual glossary for epidemiology. *J. Epidemiol. Community Health* 59 (5), 350–355. <https://doi.org/10.1136/jech.2004.024562>.
- Kwan, M.-P., 2009. From place-based to people-based exposure measures. *Soc. Sci. Med.* 69 (9), 1311–1313. <https://doi.org/10.1016/j.socscimed.2009.07.013>.
- Kwan, M.-P., 2012. How GIS can help address the uncertain geographic context problem in social science research. *Spatial Sci.* 18 (4), 245–255. <https://doi.org/10.1080/19475683.2012.727867>.
- Lin, L., Moudon, A.V., 2010. Objective versus subjective measures of the built environment, which are most effective in capturing associations with walking? *Health Place* 16 (2), 339–348. <https://doi.org/10.1016/j.healthplace.2009.11.002>.
- Longhurst, R., 1997. (Dis) embodied geographies. *Prog. Hum. Geogr.* 21 (4), 486–501.
- Lykes, M.B., Crosby, A., 2013. Feminist practice of action and community research. *Fem. Res. Pract.* 38.
- Macintyre, S., Ellaway, A., Cummins, S., 2002. Place effects on health: how can we conceptualise, operationalise and measure them? *Soc. Sci. Med.* 55 (1), 125–139.
- Manjarrez, C.A., Popkin, S.J., Guernsey, E., 2007. Poor Health: Adding Insult to Injury for HOPE VI Families: (725572011-001). American Psychological Association [Data set]. <https://doi.org/10.1037/e725572011-001>.
- Matthews, S.A., 2008. The salience of neighborhood. *Am. J. Prev. Med.* 34 (3), 257–259. <https://doi.org/10.1016/j.amepre.2007.12.001>.
- Matthews, S.A., 2011. Spatial polygamy and the heterogeneity of place: studying people and place via egocentric methods. In: Burton, L.M., Matthews, S.A., Leung, M., Kemp, S.P., Takeuchi, D.T. (Eds.), *Communities, Neighborhoods, and Health*. Springer New

- York, New York, NY, pp. 35–55. https://doi.org/10.1007/978-1-4419-7482-2_3.
- Matthews, S.A., Yang, T.-C., 2013. Spatial polygamy and contextual exposures (SPACES): promoting activity space approaches in research on place and health. *Am. Behav. Sci.* 57 (8), 1057–1081. <https://doi.org/10.1177/0002764213487345>.
- McEwen, B.S., 1998. Stress, adaptation, and disease. *Allostasis and allostatic load*. *Ann. N. Y. Acad. Sci.* 840, 33–44.
- Merkin, S.S., Basurto-Dávila, R., Karlamangla, A., Bird, C.E., Lurie, N., Escarce, J., Seeman, T., 2009. Neighborhoods and cumulative biological risk profiles by race/ethnicity in a national sample of U.S. Adults: NHANES III. *Ann. Epidemiol.* 19 (3), 194–201. <https://doi.org/10.1016/j.annepidem.2008.12.006>.
- Merlo, J., 2011. Contextual influences on the individual life course: building a research framework for social epidemiology. *Psychosoc. Interv.* 20 (1), 109–118.
- Milton, S., Pliakas, T., Hawkesworth, S., Nanchahal, K., Grundy, C., Amuzu, A., et al., 2015. A qualitative geographical information systems approach to explore how older people over 70 years interact with and define their neighbourhood environment. *Health Place* 36, 127–133. <https://doi.org/10.1016/j.healthplace.2015.10.002>.
- Mujahid, M.S., Diez Roux, A.V., Morenoff, J.D., Raghunathan, T., 2007. Assessing the measurement properties of neighborhood scales: from psychometrics to ecometrics. *Am. J. Epidemiol.* 165 (8), 858–867. <https://doi.org/10.1093/aje/kwm040>.
- Nazmi, A., Diez Roux, A., Ranjit, N., Seeman, T.E., Jenny, N.S., 2010. Cross-sectional and longitudinal associations of neighborhood characteristics with inflammatory markers: findings from the multi-ethnic study of atherosclerosis☆☆☆. *Health Place* 16 (6), 1104–1112. <https://doi.org/10.1016/j.healthplace.2010.07.001>.
- NCHE, 2017. National Collaborative for Health Equity, Collaboratives for Health Equity Initiative. <http://www.nationalcollaborative.org/our-programs/collaboratives-for-health-equity-che/>, Accessed date: 15 May 2017.
- Needham, B.L., Carroll, J.E., Diez Roux, A.V., Fitzpatrick, A.L., Moore, K., Seeman, T.E., 2014. Neighborhood characteristics and leukocyte telomere length: the multi-ethnic study of atherosclerosis. *Health Place* 28, 167–172. <https://doi.org/10.1016/j.healthplace.2014.04.009>.
- O'Campo, P., 2003. Invited commentary: advancing theory and methods for multilevel models of residential neighborhoods and health. *Am. J. Epidemiol.* 157 (1), 9–13. <https://doi.org/10.1093/aje/kwf171>.
- Ospuyk, T.L., Acevedo-Garcia, D., 2010. Beyond individual neighborhoods: a geography of opportunity perspective for understanding racial/ethnic health disparities. *Health Place* 16 (6), 1113–1123. <https://doi.org/10.1016/j.healthplace.2010.07.002>.
- Park, M., Verhoeven, J.E., Cuijpers, P., Reynolds III, C.F., Penninx, B.W.J.H., 2015. Where you live may make you old: the association between perceived poor neighborhood quality and leukocyte telomere length. *PLoS One* 10 (6). <https://doi.org/10.1371/journal.pone.0128460>.
- Parr, H., 2002. Medical geography: diagnosing the body in medical and health geography, 1999–2000. *Prog. Hum. Geogr.* 26 (2), 240–251. <https://doi.org/10.1191/0309132502ph367pr>.
- Pastor, M., Morello-Frosch, R., 2014. Integrating public health and community development to tackle neighborhood distress and promote well-being. *Health Aff.* 33 (11), 1890–1896. <https://doi.org/10.1377/hlthaff.2014.0640>.
- Pearce, J., Shortt, N., Rind, E., Mitchell, R., 2016. Life course, green space and health: incorporating place into life course epidemiology. *Int. J. Environ. Res. Publ. Health* 13 (3), 331. <https://doi.org/10.3390/ijerph13030331>.
- Perchoux, C., Chaix, B., Cummins, S., Kestens, Y., 2013. Conceptualization and measurement of environmental exposure in epidemiology: accounting for activity space related to daily mobility. *Health Place* 21, 86–93. <https://doi.org/10.1016/j.healthplace.2013.01.005>.
- Petersen, K.L., Marsland, A.L., Flory, J., Votruba-Drzal, E., Muldoon, M.F., Manuck, S.B., 2008. Community socioeconomic status is associated with circulating interleukin-6 and C-reactive protein. *Psychosom. Med.* 70 (6), 646–652. <https://doi.org/10.1097/PSY.0b013e31817b8ee4>.
- Petteway, R.J., 2014a. Towards a people's social epidemiology: envisioning a more inclusive and equitable approach to social epi research and practice in the 21st century. In: 142nd Meeting of the American Public Health Association, New Orleans, LA, November 15–19.
- Petteway, R.J., 2014b. Placescapes and the Geography of Embodiment: A New Paradigm for Understanding Place and Health Across the Lifecourse. In: 142nd Meeting of the American Public Health Association, New Orleans, LA, November 15–19.
- Petteway, R.J., 2015. Public housing is public health: intergenerational photovoice perspectives of place, health, and opportunity in the “structure(d) struggle” among public housing residents. In: 143rd Meeting of the American Public Health Association, Chicago, IL, October 31–November 4.
- Petteway, R.J., 2017. Real limits of imaginary lines: a participatory activity space method for exploring intergenerational (dis)connections between ‘place’ and health. In: 145th Meeting of the American Public Health Association, Atlanta, GA, November 4–8.
- Petteway, R.J., Mujahid, M., Allen, A., 2019. Understanding Embodiment in Place-Health Research: Approaches, Limitations, and Opportunities. *J. Urban Health*. <https://doi.org/10.1007/s11524-018-00336-y>. 2019 Jan 6, [Epub ahead of print].
- Pfister, D.S., Godana, G.D., 2012. *Deliberation Technology*. pp. 7.
- Pickett, K.E., Pearl, M., 2001. Multilevel analyses of neighbourhood socioeconomic context and health outcomes: a critical review. *J. Epidemiol. Community Health* 55 (2), 111–122.
- Pruitt, S.L., Jeffe, D.B., Yan, Y., Schootman, M., 2012. Reliability of perceived neighbourhood conditions and the effects of measurement error on self-rated health across urban and rural neighbourhoods. *J. Epidemiol. Community Health* 66 (4), 342–351. <https://doi.org/10.1136/jech.2009.103325>.
- Rainham, D., McDowell, I., Krewski, D., Sawada, M., 2010. Conceptualizing the healthscape: contributions of time geography, location technologies and spatial ecology to place and health research. *Soc. Sci. Med.* 70 (5), 668–676. <https://doi.org/10.1016/j.socscimed.2009.10.035>.
- Riva, M., Gauvin, L., Barnett, T.A., 2007. Toward the next generation of research into small area effects on health: a synthesis of multilevel investigations published since July 1998. *J. Epidemiol. Community Health* 61 (10), 853–861. <https://doi.org/10.1136/jech.2006.050740>.
- Diez Roux, 2007. *Neighborhoods and health: where are we and where do we go from here?* *Rev. Epidemiol. Sante Publique* 55 (1), 13–21.
- Roux, Diez, Ana, V., 2001. Investigating neighborhood and area effects on health. *Am. J. Public Health* 91 (11), 1783–1789.
- Roux, Diez, Ana, V., Mair, C., 2010. Neighborhoods and health: neighborhoods and health. *Ann. N. Y. Acad. Sci.* 1186 (1), 125–145. <https://doi.org/10.1111/j.1749-6632.2009.05333.x>.
- Rudolph, K.E., Gary, S.W., Stuart, E.A., Glass, T.A., Marques, A.H., Duncko, R., Merikangas, K.R., 2014. The association between cortisol and neighborhood disadvantage in a U.S. population-based sample of adolescents. *Health Place* 25, 68–77. <https://doi.org/10.1016/j.healthplace.2013.11.001>.
- Ruglis, J., 2011. Mapping the biopolitics of school dropout and youth resistance. *Int. J. Qual. Stud. Educ.* 24 (5), 627–637. <https://doi.org/10.1080/09518398.2011.600268>.
- Sampson, R.J., Morenoff, J.D., Gannon-Rowley, T., 2002. Assessing “neighborhood effects”: social processes and new directions in research. *Annu. Rev. Sociol.* 28 (1), 443–478. <https://doi.org/10.1146/annurev.soc.28.110601.141114>.
- Schulz, A.J., Mentz, G., Lachance, L., Zenk, S.N., Johnson, J., Stokes, C., Mandell, R., 2013. Do observed or perceived characteristics of the neighborhood environment mediate associations between neighborhood poverty and cumulative biological risk? *Health Place* 24, 147–156. <https://doi.org/10.1016/j.healthplace.2013.09.005>.
- Seeman, T., Epel, E., Gruenewald, T., Karlamangla, A., McEwen, B.S., 2010. Socio-economic differentials in peripheral biology: cumulative allostatic load: SES peripheral biology. *Ann. N. Y. Acad. Sci.* 1186 (1), 223–239. <https://doi.org/10.1111/j.1749-6632.2009.05341.x>.
- Smith, P.L.T., 2013. *Decolonizing Methodologies: Research and Indigenous Peoples*. Zed Books Ltd.
- Spielman, S.E., Yoo, E., 2009. The spatial dimensions of neighborhood effects. *Soc. Sci. Med.* 68 (6), 1098–1105. <https://doi.org/10.1016/j.socscimed.2008.12.048>.
- Sweet, E.L., Ortiz Escalante, S., 2015. Bringing bodies into planning: visceral methods, fear and gender violence. *Urban Stud.* 52 (10), 1826–1845. <https://doi.org/10.1177/0042098014541157>.
- TCE, 2017. The California Endowment, Building Healthy Communities Program Site. <http://www.calendow.org/places/>, Accessed date: 15 May 2017.
- Theall, K.P., Brett, Z.H., Shirtcliff, E.A., Dunn, E.C., Drury, S.S., 2013. Neighborhood disorder and telomeres: connecting children's exposure to community level stress and cellular response. *Soc. Sci. Med.* 1982 (85), 50–58. <https://doi.org/10.1016/j.socscimed.2013.02.030>.
- Tong, C., Sims-Gould, J., McKay, H., 2016. InterACTIVE Interpreted Interviews (I3): a multi-lingual, mobile method to examine the neighbourhood environment with older adults. *Soc. Sci. Med.* 168, 207–213. <https://doi.org/10.1016/j.socscimed.2016.08.010>.
- van Deuren, I., Rod, N.H., Christensen, U., Hansen, Å.M., Lund, R., Dich, N., 2016. Neighborhood perceptions and allostatic load: evidence from Denmark. *Health Place* 40, 1–8. <https://doi.org/10.1016/j.healthplace.2016.04.010>.
- Van Wart, S., Tsai, K.J., Parikh, T., 2010. Local ground: a paper-based toolkit for documenting local geospatial knowledge. In: *ACM Symposium on Computing for Development (DEV)*, London, UK December 17–18, 2010.
- Wang, C., Burris, M.A., 1997. Photovoice: concept, methodology, and use for participatory needs assessment. *Health Educ. Behav.: Offic. Publ. Soc. Public Health Educ.* 24 (3), 369–387. <https://doi.org/10.1177/109019819702400309>.
- Weden, M.M., Carpio, R.M., Robert, S.A., 2008. Subjective and objective neighborhood characteristics and adult health. *Soc. Sci. Med.* 66 (6), 1256–1270. <https://doi.org/10.1016/j.socscimed.2007.11.041>.
- Wen, M., Hawkey, L.C., Cacioppo, J.T., 2006. Objective and perceived neighborhood environment, individual SES and psychosocial factors, and self-rated health: an analysis of older adults in Cook County, Illinois. *Soc. Sci. Med.* 63 (10), 2575–2590. <https://doi.org/10.1016/j.socscimed.2006.06.025>.