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Systematic review of the use of Google Street View in health research: Major themes, strengths, weaknesses and possibilities for future research[☆]

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ABSTRACT

We systematically reviewed the current use of Google Street View (GSV) in health research and characterized major themes, strengths and weaknesses in order to highlight possibilities for future research. Of 54 qualifying studies, we found that most used GSV to assess the neighborhood built environment, followed by health policy compliance, study site selection, and disaster preparedness. Most studies were conducted in urban areas of North America, Europe, or New Zealand, with few studies from South America or Asia and none from Africa or rural areas. Health behaviors and outcomes of interest in these studies included injury, alcohol and tobacco use, physical activity and mental health. Major strengths of using GSV imagery included low cost, ease of use, and time saved. Identified weaknesses were image resolution and spatial and temporal availability, largely in developing regions of the world. Despite important limitations, GSV is a promising tool for automated environmental assessment for health research. Currently untapped areas of health research using GSV include identification of sources of air, soil or water pollution, park design and usage, amenity design and longitudinal research on neighborhood conditions.

1. Introduction

Since its development and official launch in the United States in 2007, Google Street View (GSV, a component of Google Maps) has become a source of 'big data' characterized by high spatial resolution, freely available images that provide panoramic views of homes, streets, businesses and neighborhoods at eye-level (Charreire et al., 2014). Currently, GSV is available for a number of cities globally, including almost complete coverage of the cities in many developed countries. Less-developed and rural areas or footpaths are also being added to the GSV database (Google, 2018). On the other hand, public backlash driven by privacy norms in many European countries (e.g., Germany) has restricted the amount and detail of GSV coverage available (Miller and O'Brien, 2013).

The image data for GSV is typically collected from cars equipped with special cameras capturing overlapping images that are reconstructed into a 360° view linked to GPS data identifying the location of the image. Neighborhood image data are then updated by Google at a frequency that is dependent upon population density and weather conditions (Google, 2018). The older images, dating back to 2007, are retained and are now viewable through a timeline feature released in 2014 (Shet, 2014).

GSV is an emerging source of data for health researchers. Research uses may include auditing the built environment of neighborhoods via the development of outcome- or exposure-specific tools, which rely on GSV data in lieu of the costly, time-consuming and/or impractical in-person auditing (Charreire et al., 2014; Fleischhacker et al., 2013). Assessment of exposures in the built environment is an established area of health research, for both mental and physical health outcomes (Li et al., 2015a). For example, maintained and visible urban green spaces have been associated with a multitude of positive health outcomes for nearby residents, including the facilitation of physical activity and the promotion of positive mental well-being (Barton and Pretty, 2010). Conversely, areas characterized by disorder (e.g., broken windows, graffiti) have been associated with negative social and health outcomes such as fear of crime (Bader et al., 2015). GSV offers an opportunity to assess the built environments of many places for relatively little time or financial cost. In addition to exposure assessment, emerging research

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Table 1
Summary of health studies included in this systematic review. Studies are organized based on purpose for using GSV and then alphabetically.

Study	Study location	Reason for using GSV	Health outcome/behavior of interest	GSV image data used (quantity)
Built environment assessment				
Adu-Brimpong et al. (2017)	Washington, D.C., USA	Neighborhood walkability	Physical activity	Active Neighborhood Checklist and Walk Score items (12 street segments for each of 82 homes)
Bader et al. (2015)	Unidentified metropolitan locations, USA	Neighborhood walkability and disorder	Mental health	CANVAS items (300 census tracts)
Bader et al. (2016)	New York City, New York, San Jose, California, Philadelphia, Pennsylvania Detroit, Michigan, USA	Neighborhood disorder	Mental health	CANVAS items (1826 street segments)
Badland et al. (2010)	Auckland, New Zealand	Neighborhood walkability	Physical activity	NZ-SPACES items (48 street segments)
Ben-Joseph et al. (2013)	Boston, Massachusetts, USA	Obesogenic features	Physical activity	Brownson et al. 2004 items (84 street segments)
Bethlehem et al. (2014)	Randstad megalopolis, Netherlands	Obesogenic features	Physical activity	SPOTLIGHT items (128 street segments)
Brookfield and Tilley (2016)	Edinburgh, United Kingdom (UK)	Neighborhood walkability	Physical activity	FASTVIEW items (19 walking routes)
Chudyk et al. (2014)	Vancouver, British Columbia, Canada	Neighborhood walkability	Physical activity	Walk Score items (48 street segments)
Clarke et al. (2010)	Chicago, Illinois, USA	Neighborhood features	Mental health	CCAHS items (224 street segments)
Clews et al. (2016)	Wellington, New Zealand	Alcohol-related data	Alcohol-related health	Alcohol signage (12 street segments)
Compernolle et al. (2016)	Five European urban regions	Obesogenic features	Physical activity	SPOTLIGHT items (4486 street segments)
Curtis et al. (2013)	Five regions in United States recently subjected to natural disaster	Imagery date changes in study site	Generalized health	Street segments (281,591.66 total meters)
Evans-Cowley and Akar (2014)	Columbus, Ohio, USA	Bikeability	Injury prevention for bicyclists	Bike route (59)
Feuillet et al. (2016)	Five European urban regions	Obesogenic features	Physical activity	SPOTLIGHT items (4486 street segments)
Griew et al. (2013)	Wigan, UK	Neighborhood walkability	Physical activity	FASTVIEW items (54 street segments)
Gullón et al. (2015)	Madrid, Spain	Neighborhood walkability	Physical activity	M-SPACES items (500 street segments)
Hanson et al. (2013)	New Jersey, USA	Audit of crash site	Pedestrian death	2351 crash sites
Hyam (2017)	Edinburgh, UK	Perceived naturalness	Mental health	Random panoramic images (768)
Johnson and Gabler (2015)	Michigan, USA	Audit of guard rails	Traffic injury	Crash sites (1,001)
Kelly et al. (2013)	St. Louis, Missouri and Indianapolis, Indiana, USA	Obesogenic features	Physical activity	Active Neighborhood Checklist items (288 street segments)
Kelly et al. (2014)	St. Louis, Missouri and Indianapolis, Indiana, USA	Obesogenic features	Physical activity	Active Neighborhood Checklist items (400 street segments)
Kepper et al. (2016)	Louisiana, USA	Neighborhood "incivilities"	Physical activity	Checklist items (84 homes and street segments)
Kepper et al. (2017)	Southeast Louisiana, USA	Neighborhood disorder (perceived safety)	Mental health	Street segments (54)
Lafontaine et al. (2017)	Ottawa, Ontario, Canada	Environment aesthetics	Mental health	Residential blocks (150)
Li et al. (2015a)	New York City, New York, USA	Street greenery	Mental health	Green space pixels (300 sites)
Li et al. (2015a)	Hartford, Connecticut, USA	Street greenery	Mental health	Green space pixels (3000 sites)
Li et al. (2015b)	Boston, Massachusetts and New York City, New York, USA; Linz, Salzburg, Austria	Neighborhood disorder (perceived safety)	Mental health	GSV images (4126)
Li et al. (2016)	Hartford, Connecticut, USA	Street greenery	Mental health	Green space pixels (18 images)
Marco et al. (2017)	Valencia, Spain	Neighborhood disorder	Mental health	Itemized checklist of disorder criteria (92 census block groups)
Mertens et al. (2017)	Five European urban regions	Bikeability	Physical activity	SPOTLIGHT items (4486 street segments)
Mooney et al. (2014)	New York City, New York, San Jose, California, Philadelphia, Pennsylvania Detroit, Michigan, USA	Neighborhood disorder	Mental health	CANVAS items (1826 block faces)
Mooney et al. (2016)	New York City, New York, USA	Audit of intersections	Pedestrian injury	Walk Score items (532 intersections)
Mygind et al. (2016)	Victoria, Australia	Quality, public open spaces	Physical activity	POSDAT items (171 open spaces)
Naik et al. (2014)	Boston, Massachusetts and New York City, New York, USA; Linz, Salzburg, Austria	Neighborhood disorder (perceived safety)	Mental health	Streetscore items (4109 GSV images)
Odgers et al. (2012)	England and Wales, UK	Neighborhood disorder	Mental health	SSO i-Tour items (2024 children's streets)
Pliakas et al. (2017)	England and Scotland, UK	Walkability/transportation	Geriatric health	OPECR tool (1396 street segments)
Porzi and Bul (2015)	Boston, Massachusetts and New York City, New York, USA; Linz, Salzburg, Austria	Neighborhood disorder (perceived safety)	Mental health	Automatic scene recognition in GSV images (4136)
Quinn et al. (2016)	New York City, New York, USA	Neighborhood disorder	Mental health	CANVAS items (532 block faces)
Roda et al. (2016)	Five European urban regions	Obesogenic features	Physical activity	SPOTLIGHT items (60 neighborhoods)
Rundle et al. (2011)	New York City, New York, USA	Neighborhood disorder	Mental health	Block faces (37)
Silva et al. (2015)	Sao Paulo, Brazil	Obesogenic features	Physical activity	Objective Evaluation of Environment items (29 street segments)

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