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Physical activity and the human body in the (increasingly smart) built environment

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Abstract

Physical activity in the built environment of high income countries may be changing faster than at any time prior to the 2000s, with the engagement of social media, smart devices and increasing urban smartness that has come with the Internet of Things. This article describes the most salient features of built environments that have facilitated physical activity between the 1980s and 2000s (most importantly walkability and active transport with bicycles). It goes on to use the anthropological three bodies framework in association with that of forms of capital to explore how the use of smart devices and increasing incorporation of smartness and performativity into architecture and urban planning since the 2000s might influence physical activity. Smartness and use of smart devices in the built environment should favour increased physical activity through new types of sociality that they facilitate. In turn, engagement with such technologies offers an important opportunity for the empowerment of individual body-self and the social body towards increased physical activity.

Introduction

The built environment has been defined in various ways, including as the physical form of human communities (1), and as the anthropogenic surroundings that are the settings for human activity (2). The built environment differs from the non-built environment in the greater diversity of ways in which it can shape physical activity patterns. It includes ways in which urban space is configured and organised, the types and organisation of large- and small-scale built and natural features (including architectural details and the quality of landscaping), transportation systems (the facilities and services that interconnect locations and link one place to another), and environmental outputs from such configuration and organisation, including air quality, pollution and perceptions of risk for personal safety. These elements and factors help to shape both access to opportunities for physical activity and activity behaviour in the built environment (3).

Physical activity is a term used in public health to try to capture the integration of complex behaviours associated with human movement (4), and relate them to measures of health and illness. The built environment encompasses a range of spatial scales, from very local ones involving the immediate interactions of individuals with the space around them, to buildings, neighbourhoods and districts, and entire metropolitan areas. Prior to the development of efficient tools and agriculture, humans had very high levels of physical activity (5), but after two centuries of rapid urbanization and industrialization, human populations living in urban places now have far lower levels of physical activity than ever before (6). Urbanism is integral to human ecology (7), and physical activity patterns of the

majority of the world's population are now influenced by urban form and function. Globally, the pervasive forces of urbanisation, mechanisation, and changes in transportation patterns have led to declines in physical activity (8), with the more general shift from physically demanding material labour to usually sedentary immaterial labour in the economies of high income countries (HICs) (9).

Links between physical activity and health are increasingly known (10), if not always straightforward (11). Low levels of physical activity among many populations have been clearly framed as a public health problem (12), especially in the context of living in obesogenic environments (13) which facilitate over-eating relative to need and partaking in sedentary activities. Obesogenic environments are easily characterized as involving a great preponderance of motorized transport and of sedentary occupations, and the cheap and easy availability of high fat and highly refined-carbohydrate foods (14). Such environments have been created, largely unwittingly with no single modernizing force that can be held responsible for them. Rather, they are produced by the entanglement of expert systems which have arisen across the past forty years or so - including expert systems of food, transport and urban planning - none of which have sought obesity as an outcome (15). An expert system is defined by the complex task it is developed to perform, with the aim of replacing or aiding human expertise. Expert systems emerged as a field in computation in the 1970s, as a way of problem-solving that could deal with the societal complexity (16) that has come with increasing globalization. Expert systems methods underpin the smooth running of everyday life, especially in the built environments of HICs, including the provision of ever-available water, electricity, food, transport, communication infrastructure, health services, and welfare provision.

Construction, retail, transportation, urban planning, engineering, distribution planning and public transport are areas that benefit from expert systems methods (15), and which have some influence on physical activity. Expert systems interact with each other, often to good purpose, but sometimes with negative outcomes, as with directing the populations of HICs towards reduced physical activity levels and the production of increasing rates of obesity (15).

Linked to expert systems are expert devices. Since the late 2000s, electronically connected devices have become ubiquitous in HICs, increasingly mediating the relationships between individuals and the built environment, with additional implications for physical activity. Personal electronic devices have become increasingly smart and are almost universally used in HICs. Smartness in this context refers to the networked and interactive properties of electronic devices and technologies that can recruit both human and artificial intelligence to perform a wide range of functions. As cities become increasingly smart (17), the relationships between urban structures and human activity patterns are likely to become increasingly mediated by such structuring smartness, and this also has implications for physical activity. How to understand emergent smartness at the individual, social and structural levels is a growing issue. With respect to understanding smartness and its relationships with physical activity, conventional epidemiology is of limited use, because it is difficult to know what to quantify and what quantification would mean. In this article, relationships between physical activity and increasing smartness in the built environment is examined by drawing on the anthropological frameworks of the three bodies (18), and of forms of capital (19).

Physical activity, the built environment and the three bodies

Recognizing the structural issues that influence individual physical activity patterns, Baumann et al (8) put forward an ecological model of the determinants of physical activity, from the individual to the global, from early life to older age. **Figure 1** shows a modified form of this, in relation to the three bodies framework, forms of capital, and technological smartness. Factors that influence physical activity vary across the life course, and invoke different types of policy intervention, from individualist to social and structural. Physical activity by definition requires bodily engagement, and the three bodies framework (18) theorizes three levels of human bodily experience. These are: the individual body-self, which is phenomenologically experienced (for example, in the act of swimming outdoors); the social body, a natural symbol for thinking about relationships among society, nature and culture (for example, in the social activity of swimming outdoors with other people); and the body politic, where the human body is under social and political control (for example, in the regulation of where individuals and groups can and cannot swim outdoors). At the level of the individual body self, biological factors (including those involving the mind) are key to promoting physical activity, as are policy approaches that target the individual (Table 1). At the level of the social body, policy is social and structural, while factors influencing physical activity are both interpersonal and environmental. At the level of the body politic, factors influencing physical activity and policy influencing it are overwhelmingly structural. The importance of each of the three bodies to physical activity intervention varies according to social level, from individual, interpersonal, regional or national policy, to the global level. The forms of capital that associate with patterns of physical activity also range from the embodied and aesthetic through to

social, institutional and economic (**Figure 2**).

Figures 1 and 2 about here

Of individual-level factors in HICs, age, sex, health status, self-efficacy, and motivation have been identified as being positively associated with levels of physical activity in HICs. At a higher level of organisation, land use mix, connectivity, population density and overall neighbourhood design have been identified as important determinants of individual physical activity. Walking as a form of transport, more than walking as a form of recreation, is perhaps the most important for maintaining health in the built environment (20), because this is usually the most frequently performed type of physical activity. For children, the most robust correlates with higher levels of physical activity in the built environment are walkability, low traffic speed and volume, mixed land use with close proximity of homes to destinations such as shops, high residential density, and high access or close proximity to recreational facilities (21). For adolescents, mixed land-use and high residential density are the most strongly related to higher levels of physical activity (21). With respect to the built environment and the physical activity of adults, this is most strongly related to higher availability of recreation facilities and locations, greater active and public transportation, and higher perceived aesthetic value of local built environments (8), as well as other exogenous factors including environmental pollution and air quality.

Baumann et al's (8) ecological model of the determinants of physical activity is most persuasive at the individual level, reflecting the greater strength of evidence in, and relative dominance of, individualist approaches in epidemiology and public health.

Little is known about what influences physical activity levels at the societal and global levels, however (8), since individual behaviours can be much more easily observed and analysed than can social or political ones. Concerning possible effects of different societal trends on physical activity, Baumann et al (8) refer to economic crises, civil unrest, and natural disasters as having the potential to change physical activity levels. In addition, social media have the potential to influence physical activity at both individual and group levels (22). Concerning global factors influencing physical activity patterns, Lazzarato (9) describes the effects of shifts from material labour (based on physically-active work) to immaterial labour (based on usually sedentary mentally active work) on reducing physical activity levels in HICs since the 1980s.

Currently, changing human behaviour towards activities that promote health is most commonly undertaken using nudge tactics at the individual level (23). Nudge-based policies require comparatively little governmental commitment and can attempt to encourage individuals to greater self-governance (24) in pursuing healthy levels of physical activity and other health-promoting behaviours. Shaping built environments towards similar goals usually requires political involvement, at several levels (25). Structurally, governmental policy can influence levels of physical activity (26), but this requires strong political commitment. For example, in Germany, Denmark, and the Netherlands, governmental policy since the 1970s which has promoted cycling – towards the development and maintenance of infrastructure, trails, and parks – have together led to increased physical activity levels (27). In these three countries, the success of cycling as a form of active transport was only achieved in combination with the provision of separate cycling facilities along heavily travelled roads and at

intersections, traffic calming in residential neighbourhoods, plentiful cycle parking, full integration with public transport, as well as comprehensive traffic education and training of both cyclists and motorists, and governmental promotion of cycling (27).

Public health and economic interventions to increase physical activity of populations classically come from the body politic. Public health usually focusses on changing the individual body-self by encouraging self-regulation through the provision of information, education and nudging. Economic interventions usually focus on regulating the individual through environmental and policy approaches (28). The social body is usually excluded from these two approaches, and is only considered in paternalist policy approaches (29). Individuals are connected within families, social structures and friendship networks, and influencing social relationships may be as important in structuring physical activity patterns in the built environment as individualist and governmental factors.

Attempts to move attention to changing physical activity levels from the level of the individual to that of society raises large ecological questions. Should people be driving motor cars to work, rather than taking active or public transport? Should people's work and living arrangements be separated to the extent that they cannot walk or cycle to work or school? At the societal level, human physical activity is not just about the human body and disciplining it, but about the structures that make certain patterns of individual physical activity easier to perform than others. This is echoed in discourses of obesogenic environments (13). Such environments are part of the urban landscape in most HICs, and have been inadvertently created by major

institutional and structural forces, including political ones. For example, the planning of suburban sprawl and motor car use and the planning away of walkability and cyclability for the sake of modernity and convenience led to reduced physical activity in the urban environments before the 2000s in the United States (3) and other HICs. Furthermore, social and material structures that make life convenient and energy-efficient at the individual level can also reduce physical activity and promote obesity (30). In Perth, Australia, for example, the older city was restructured using a modernist metropolitan plan based on low-density suburban housing, car transport and a freeway system (31). The city was thus structured around separated land use, with work in one place, and shopping, recreation, and sleeping in other locations (32). Signs throughout the city centre stated boldly that ‘your car’s as welcome as you are’ (32). This modernist approach also included the displacement of small local shops that could be walked to, and the simultaneous construction of large supermarkets that require a car for access and which encourage food shopping in bulk. By contrast, in Copenhagen, cycling as a mode of transport for food shopping places a physical limit on the volume of food that can be bought at one time – the ‘can it all fit on a bicycle’ principle. In Perth and elsewhere, modernist urban planning from the 1950s to the 1990s has led to ever-increasing commuting times, and the speeding up of everyday life such that most adults become time-stressed most of the time.

Once built, urban environments cannot be easily changed, but they can be retro-fitted for increased physical activity of the populations negotiating them. For example, Perth, Australia, was in 1993 the first city outside Scandinavia to conduct a major ‘Public Spaces Public Life’ survey to help guide how to improve walkability and

cyclability in the city (32), a study that was repeated in 2009 (33). Along with Canberra, Perth now has the highest proportion of all trips taken by bicycle among all major cities in Australia (although it still lags far behind cities in Germany, Denmark and the Netherlands) (27).

Declines in physical activity have followed the growth of the built environment in the second half of the twentieth century, with a number of interrelated factors contributing - economic change, economic insecurity, suburbanization, declining traditional industries, the comfort-eating that assuages individual insecurity, the ready availability of cheap convenient high energy density foods and the motorized transport with which to get it. These changes have happened against a back-drop of almost universal sedentary leisure and rising economic inequality in most HICs (15) that has helped structure the urban environment, such that the lowest in status have become the least physically active. A clear exception to this is the move to change urban structure for improved health, with the call for healthy place-making in designing, building, renovating, and operating buildings, neighbourhoods, and metropolitan areas, by urban planners, architects, landscape architects, developers, builders, building managers, and others. Another positive change has been the call to incorporate health routinely into urban planning (34), especially through the promotion of smartness in cities using expert systems.

Physical activity as capital

Human physical activity is neither neutral nor value-free, it being variously associated with economic, social, and recreational purposes that are linked to human capital formation (19). Physical activity as physical labour (as a means of

gaining payment, or economic capital) has declined in HICs, and physical activity is now more importantly a means of attaining embodied cultural capital (15, 19, 35), valued among other types of capital, including social and economic forms (Figure 1). Embodied cultural capital is clearly displayed among those who are athletic, and who perform their activities publicly, cyclists and runners among them, but is possessed in varying degree by the general population. Physical inactivity, especially when linked to overweight and obesity in most HICs, is easily allied with lack of embodied cultural capital, and is open to moral judgement, especially when related to body fatness and in contexts where higher levels of physical activity are a moral norm, as among higher social classes in HICs (15). The morality of physical activity is as much about imposing order on an inactive world as about health, and body morality in a world of rising obesity rates can been seen as a form of order-making in an untidy world increasingly inhabited by fat bodies. Individuals discipline their bodies for what is viewed as appropriate moral behaviour by those with most capital in society, producing morally-correct bodies. This is done against a back-drop of political ecological factors that make bodily thinness more difficult in most HICs. Physical activity levels and patterns thus reflect varied degrees of interest in, and striving for, embodied cultural capital, usually at all levels of the three bodies framework.

Aesthetic capital (36) is a form of cultural capital (non-financial assets that involve educational, social, and intellectual knowledge) (19), which is largely symbolic and distinct from both economic and social capital (37), but which overlaps with embodied capital (38) (Figure 1). It is produced through aesthetic labour (39) and body work (40), and engages both the individual body-self and the social body. Body

work has been described as involving the practices that women engage in to achieve the beauty ideals of western (primarily United States) culture, and include gym work and dieting (40), practices that can be easily extended to men. Body work overwhelmingly requires physical activity. Beauty, physical fitness and good looks are forms of aesthetic capital, very often developed through body work, and come with benefits (41), including sexual attractiveness and attributions of moral goodness and economic success (the ‘halo effect’, the assumption that people with visible desirable traits also have other, perhaps less visible, positive qualities). Aesthetic capital has come to be important across society, initially for celebrities, but increasingly for politicians, leaders, athletes and everyday citizens (42). Most people have some understanding of their own aesthetic traits (37), and because beauty can be accomplished as well as inherited, people purchase products (43) and engage in aesthetic labour (44, 45) and/or body work (46) to enhance their position, especially socially and economically. Physical activity is not performed by individuals simply for the sake of health, but also perhaps more importantly in negotiating everyday life with the aesthetic capital that it can generate.

A central feature of aesthetic capital is that it relies on consumption; in recent decades consumerism has displaced production and wage labour in the creation of value and meaning (47) in most HICs. Individuals negotiate society and the social system as consumers rather than producers (48), and physical activity in HICs has moved from being a force for production to being packaged for consumption, as with health and fitness clubs, for example. According to Frew and Gillivray (49), as the consumers of health and finess clubs seek to attain desired forms of embodied

capital, such clubs both capitalize on and perpetuate cycles of embodied dissatisfaction, and are anything but healthy from a social perspective.

Forms of capital are interchangeable, and embodied capital can be more unquestionably transferred across generations than economic capital because of its seemingly natural and biological appearance, allowing societal inequality to be perpetuated across generations more easily in this way than wealth, which is at least subject to governmental control through taxation (50). Physical activity is a therefore a seemingly neutral way for dominant classes in society to perpetuate their dominant position (19), while making certain types of physical activity appear more elite.

~~Shilling (50) has addressed the question of why individuals from dominant classes invest time and resources in the acquisition of embodied capital, when they could use their material wealth to invest in other forms of capital. The answer to this lies in the natural and biological appearance of such capital (50). As a consequence of the naturalized appearance of embodied capital, the attempts of one generation to cultivate it in the next are usually heavily disguised or even invisible. The social conditions of the (indirect) inter-generational transmission of embodied capital are much less visible than the (direct) transmission of economic capital. Consequently, while governments may attempt to control the inter-generational transmission of economic capital (through taxation), the development of embodied capital is a hidden form of privilege which can nonetheless be re-converted into economic capital. As such, dominant classes are likely to invest a considerable amount of time and money in elite activities for themselves and their children, to maximise the potential production and conversion of embodied capital. Indeed, the more the state is able to~~

~~prevent or hinder the official transmission of economic capital, the more the effects of clandestine circulation of embodied capital are likely to affect the reproduction of the social structure (19).~~ In HICs, people of lower socioeconomic status are in general less physically active (51, 52), and there is a risk that the promotion of physical activity by public health is inadvertently an agent of societal inequality production through the economically differentiated desire to build aesthetic and symbolic capital.

A way of bypassing social and economic inequalities in different forms of capital in the built environment would be to build on the common desire among most people to accumulate aesthetic capital. The contexts in which this could happen are important. Physical activity in the built environment is related to a number of factors, including local neighbourhood factors such as the availability of convenient facilities for activity (such as parks), the presence of shops or parks nearby, and safety (53), all of which vary by the economic capital of people living in different neighbourhoods. There are also physical geographic and socio-demographic effects on physical activity, including pleasant climate and urban population density (53), and having clean air to breathe. Urban planning can also have some unintended consequences for walkability. For example, tower blocks concentrated in a small area result in channelling, or an acceleration of wind (especially at ground level) as moving air forces through narrow spaces, often making it unpleasant or difficult to walk. Limiting the height of tower blocks (as in Copenhagen) and more recently twisted (as with the Turning Torso building in Malmo) or curved (as with the gherkin building in London) tower block structures help to reduce this problem. Perceived environmental aesthetics and walking companions are also important correlates of walking for exercise (53). Conversely, the perception of ‘urban disorder’ from rubbish,

abandoned property, and decay, for example, is taken as a signal of a breakdown of the local social order (54). Such perceived disorder (more common in neighbourhoods of low economic, and cultural capital) inhibits walkability (54). Conversely, when neighbourhood aesthetics are perceived in a positive way, more people will walk and cycle in that neighbourhood. Walking and cycling are also more common and more extended when there are more aesthetically pleasing destinations to visit or pass, and there is more public transport, greater access to cycle lanes, and greater numbers of physically active people in a neighbourhood. Recreational physical activity is also positively associated with perceived access to recreational facilities and more attractive features in the local environment (55). All of these positive attributes are most usually associated with neighbourhoods possessing higher levels of capital of various kinds.

Physical activity, expert systems and smart cities

The built environment is a heterogeneous assemblage, whose properties emerge from interconnections, interactions, flows and synergies between different parts (56) and interactions between the individual body-self, the social body and the body-politic, in activities that are both shaped by forms of capital and in turn shape capital formation. The places, buildings, neighbourhoods and identities that are the most visible parts of the built environment are the emergent effects of these interactions. Such assemblages of interconnected entities may not have any natural hierarchy (57), and are difficult to regulate politically, leaving space for the individual body-self and the social body to engage in behaviours and practices that can influence physical activity levels.

In most HICs, the sedentariness of everyday life is a product of nationally and locally complex urban planning systems which prioritize motor car transport above other forms (58), and of desk-chair configurations for computer-facilitated work (59). To counter this, public health research has expanded the definition of the built environment to include healthy food access, walkability and bikeability (60). Expert systems are deeply embedded in the built environment. Healthy food access requires support from the global food system, which is expert because it involves different many different processes, materialities and a wide range of organizations and people with diverse expertise (15). Walkability and cyclability of the built environment require support from the expert systems that underpin road construction, transportation, urban planning, public transport and their regulation (61), as well as of modern policing (62).

A primary function of the built environment is as infrastructure that services and maintains the economy (9), with just-in-time supply systems (63) facilitated by expert systems that streamline business and work. In this context, the individual body-self may also operate in a just-in-time way, in which physical activity is often reduced in a very personal economic way to time utility (hence the response by many time-stressed individuals that they do not have time for exercise). Expert systems operate as ecologies, and are difficult to understand, leave alone regulate by the body politic. Thus changing the built environment to encourage physical activity is difficult, because the effects of changing aspects of expert systems that underpin urban smartness cannot be fully predicted. It requires politic commitment to physical

movement in a similar way to that of the Dutch, Danish and German governments in the 1970s when they put forward deeply integrated policies for cycling as active transport (Pucher and Buehler 2008).

The discourses about smart cities are most commonly about consolidating expert systems to enhance the efficient functioning of built environments. Where people appear in these discourses, they are characterised as being creative, healthy, or both, but in all cases, the individual body-self is largely reduced to utility and economic function. There are different definitions of smart cities, but in general they are characterised by factors that contribute to urban wealth: the presence of a creative class; the quality of, and dedicated attention to, the urban environment; higher levels of education; and the accessibility to and use of information and communication technologies for public administration (17). They are also characterized by the coordinated performance of critical infrastructure (including roads, bridges, tunnels, railways, subways, airports, seaports, water and power supply systems, major buildings), strong security provision, interconnected and efficient services (city administration, education, healthcare, food), maximization of economic productivity, and enhancement of the quality of life of citizens (64). If the discourses are to be believed, the future transition to smart cities across HICs and beyond has the potential to plan away obesogenic environments, if the political will exists. When considered in terms of capital (19), urban life and economic performance can be seen as currently depending not only on a city's endowment of hard infrastructure (physical capital), but also, and increasingly so, on the availability and quality of knowledge communication and social infrastructure (the human and social capital of the individual body-self and the social body).

Planning physical activity into the built environment with smartness

The ‘smart city' agenda has thus far overwhelmingly focussed on increasing the efficiency of service provision and the soundness of infrastructure through the use of information technologies, and much less so on people. While public health encourages or nudges the individual body-self to increase physical activity, smartness with physical activity implications is increasingly planned into the built environment (for example in cycle schemes of major cities in HICs). The major, and very limited smartness employed by individuals in built environments is predominantly the use of smart phones (65), which, with respect to physical transportation activity, are most commonly used to find the speediest way from A to B. The future is likely to see greater connectedness not only between smart objects in the Internet of Things (66), but also between the body politic and the individual body-self through the social body by way of interpenetrating smartness at all levels.

The idea of ‘smart health’ is a context-aware complement of mobile health within smart cities (67) There are many challenges preventing the integration of the expert system of mobile health with other expert systems operating in smart cities (notably in the management of security, privacy and big data), and in engaging individuals in managing their own health (67). Wearable technologies might seem to be the best interface for negotiating the smart city, but these have not gained widespread acceptance at the time of writing. For example, Google Glass was launched in 2012, but has not become a widely used technology, although the development of other forms of smart wearables are an important form of economic activity. Wearable

technologies need to be better designed, more compact and lighter, to increase autonomy and have much simpler interaction processes so that personalization is made easier (67). The individual body-self in the smart city is imagined by innovators and planners as being a self-regulating citizen, who will ensure their physical activity is maintained at appropriate levels. This imagining is already materialising with the longer term use of activity sensing devices such as fitbit (68).

Self-regulating citizens would be part of the expert systems that are regulated in these built environments, via their smart devices. Alternatively, increased physical activity could be built into smart cities agendas, such that the regulation of physical activity could take place at the level of the body politic as well as at the level of the individual body-self. Smartness might turn out to be a new form of urban modernity, in which case public health should strive not to be excluded from its discourses, as it was with the wave of modernisation between the 1960s and 2000s, during which time physical activity declined to unhealthy levels.

The speediest way from A to B may be economically rational, but it does not necessarily offer the aesthetic properties that encourage people to be physical active, nor does it necessarily feed the need for improving or maintaining mental well-being. The visual qualities of urban facades not only affect aesthetic responses and people’s judgments of urban locale (69), they have stark social and psychological effects on their inhabitants (70). Quercia et al (71) have developed a smart instrument to identify the visual cues that are generally associated with concepts that are difficult to define in built environments, including beauty,

happiness, and quietness. The difficult task of deciding what makes a building beautiful, or what is sought after in a quiet location, is outsourced to the users of their website using comparisons of pictures, using visual ratings of urban sceneries. In this way London, Boston and Turin have been mapped for beauty, happiness and quietness, using London as the prototype. Compared to the shortest routes, the ones based on these three qualities are on average 12% longer, add a few extra walking minutes and are perceived as being more beautiful, quiet, and happy, respectively (72). This may be one way in which responses to aesthetics in the built environment can help to promote physical activity through the use of individualized smart technologies in increasingly smart cities. Aesthetic appreciation is mutable (73), and what may be aesthetically pleasing now may be less so for the next generation. Efforts into crowdsourcing opinion about beauty, quietness and happiness in the built environment, if continued (at present on urbangems.org), would allow this mutability to be captured and engineered into smart technologies (71). At the level of the body politic, built environments will continue to be built, and ways in which the individual body-self and the social body can negotiate them must also continue to develop.

Another organizing factor in increasingly smart cities is the extent to which they consider and incorporate performativity. In the context of urban planning, performativity represents the design and organisation of urban and architectural space to facilitate social interaction and nurture the creativity that is considered key to the urban economies of HICs which underpin smart cities agendas (74). In consideration of performative architecture, the focus is on what a building does instead of what it is said to be (which can change over time). Architecture thus becomes dynamic and open-ended in possibility, and is potentially the physical

framework for self-organizing human local communicative interactions and network behaviours (75). Performative architecture incorporates sensor technology and potentially smartness, offering people behavioural cues from the built environment (76). As urbanism in HICs increasingly involves networked mobility and sociality, this produces and re-produces complex relationships between physical location, infrastructure and people (76). New digital design techniques along with pervasive computing, sensor technologies and mobile networks (76) and increasingly the Internet of Things, will transform the built environment and the behaviour of people within it. It is important that health and well-being production through physical activity are central to the planning and creation of smart cities and the performative architecture within it.

Discussion

Physical activity patterns in the built environment of HICs may be changing faster than at any time prior to the 2000s, with the engagement of social media, smart devices and increasing urban smartness with the growth of the Internet of Things. Epidemiology has yet to find ways of analysing this change. Smart technology which facilitates physical activity offers an important opportunity for the empowerment of individual body-self and the social body which could displace the very popular nudging strategies currently employed by the body politic. There is a very real opportunity to shift thinking towards healthy built environments away from some of the older modernist programmatic forms that led to declines in physical activity to unhealthy levels. The epidemiology of physical activity only goes back to the 1990s, by which time urban planning had already engineered physical inactivity into the built

environment in many HICs. Since the 1980s, many expert systems have become involved in developing and maintaining the built environment. Such systems interact with each other, often to good purpose, but sometimes with negative outcomes, as with reducing physical activity levels. They operate as ecologies, and are difficult to understand, leave alone regulate by the body politic. Increasingly, smart technologies should help to bring people into the expert system ecology, empowering them while also having the potential to increase their physical activity levels. Such a move towards expert system involvement of the individual body-self should be to move the regulation of individual physical activity levels away from public health governmentality and nudge tactics. Ultimately, increased smartness and use of smart devices in the built environment should favour increased physical activity through new types of sociality that they facilitate. The potential for this is largely untapped, and remains enormous. Is it thus worth waiting until smart cities start to throw up new health problems associated with physical inactivity, or is it better to help plan them away with the work of institutions that have significantly more power than public health, and which actively want to make cities healthier now?

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Figure legends

Figure 1.

The three bodies and forms of capital frameworks, in relation to smart technology and ecologies of physical activity.

Figure 2.

Forms of capital associated with physical activity