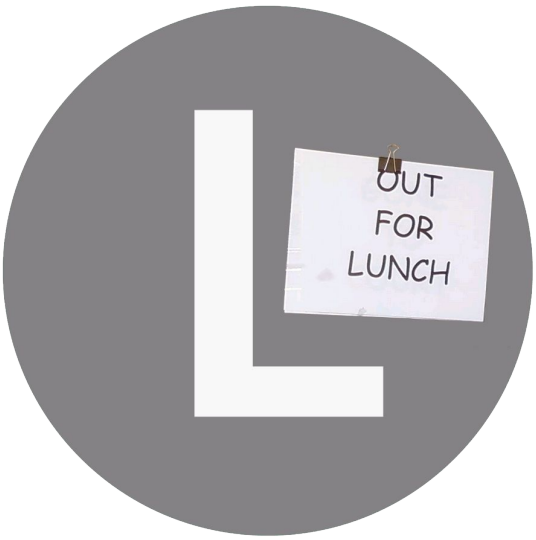

NYC L-train Shutdown

Health Impact Assessment

DEA 5560: Health Impact Assessment.
Design and Environmental Analysis.
Cornell University. Spring 2017.

Chloe Collins, Hannah Dorpfeld,
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EXECUTIVE SUMMARY

According to the Center for Disease Control and Prevention, a **Health Impact Assessment** or "HIA" is a process that helps evaluate the **potential health effects** of a plan, project, or policy before it is built or implemented (National Research Council, 2011). The purpose of an HIA is to assess the potential health risks and benefits of a particular policy and to make **recommendations** that mitigate the health risks while maximizing the health benefits. In essence, an HIA brings health to the decision making table.

The MTA has announced a **15-month shutdown** for the L-Train, one of the most crowded and widely used subway lines in New York City. Under the direction of Professor Nancy Wells, the students in the Department of Design and Environmental Analysis at Cornell University decided to conduct **this HIA** to inform policymakers of the potential health impacts of the shutdown.

There are many factors that influence or define a person's health. These are referred to as **determinants of health**. Our HIA will focus on **five key health determinants** that we believe will be particularly affected by the L-train shutdown:

(1) **Environmental Stressors:** Air Quality, Noise, and Overcrowding
(2) **Mobility:** Walkability, Wayfinding, Transportation Hazards, and Disability Access
(3) **Health Related Behaviors:** Physical Activity, Diet and Sleep
(4) **Employment and Livelihood:** Job Accessibility and Security, and Occupational Stress
(5) **Family and Community Structure:** Family Dynamics, Civic Engagement, and Leisure

Following the six steps of an HIA: **Screening, Scoping, Assessment, Recommendations, and Reporting**, we further highlight the process of how the shutdown of the L-train affects the five areas of health for L-Train commuters.

The path by which the shutdown can impact health is called a **pathway.** One example of a pathway is as follows: A **direct impact** of the L-train shutdown will be the need for commuters to use alternate forms of transportation. This may cause overcrowding on the subway platforms, or increase a person's chance of getting lost on a new route. These issues may be **exacerbated** by a decrease in the ease of walkability to new routes, a need to develop new cognitive maps for unfamiliar areas, a decrease in disability access, and a heightened risk of transportation hazards. **All of these factors** impact a person's **anxiety** levels, **stress**, sense of **control**, and may change a person's **physical activity** routines if they need to walk farther.

We also specifically identify which health determinants adversely impact **key disenfranchised populations,** including people with low-income, disabled individuals, the elderly, and children.

TOP RECOMMENDATIONS

Lastly in our HIA, we present a set of **recommendations** for policymakers to consider in order to minimize negative health impacts while maximizing positive health outcomes. Our recommendations synthesize the data we have collected through extensive review of existing literature, and our participation with community workshops and an on-site visit.

Since the main goal of a health impact assessment is to provide stakeholders with the recommendations that we believe are the **most feasible, vital to accomplish, and will help the widest number of people,** we present the following table that delineates the top priority recommendations from the larger list in the document, to consider for implementation.

Recommendation	Priority	Feasibility
The NYC DOT and MTA should partner with a major navigation app company such as Google Maps or MapQuest to provide a phone application for persons confined to a wheelchair that recommends the easiest route to use to get around during the L-train shutdown.	☆ ☆ ☆	△ △ △
Create pamphlets and signage that have maps with alternative routes highlighted and color-coded. These elements can be available at any L-train stop for people to plan out their new routes in advance, and allow themselves time to mentally acclimate to the change.	☆ ☆ ☆	△ △ △
Have safety training sessions for all transit operators that instructs them on how to safely manage the new larger volumes of passengers.	☆ ☆ ☆	△ △
The MTA can expand public programs like Poetry in Motion, and commission artists to create artwork to display on subways and buses that promote calm moods, positivity, and thoughtfulness.	☆ ☆	△ △ △
Have advertisements and announcements in subways and trains encourage commuters to engage in small acts of kindness e.g. give up one's seat, conversing with fellow commuters (Wei 2015).	☆ ☆	△ △ △
Increase the frequency and availability of ferry rides; have shuttle services that make it easier to reach ferry ports.	☆ ☆	△
Partner with the Department of City Planning to plant shrubs and trees along roads and on street medians to provide a buffer between vehicles and the natural and built environments and reduce poor air quality effects on individuals with preexisting asthmatic conditions (Lovasi, 2008).	☆ ☆	△ △
Partner with the Department of City Planning to install parklets around areas with high pedestrian traffic. Parklets can offer rest or waiting areas, as well as provide greenery and nature to help reduce stress from crowding.	☆ ☆	△
Install NYC DOT's Select Bus Service wayfinding totems that provide real-time information at all Brooklyn stops.	☆ ☆	△ △
Offer daily challenges or physical activity goals to convince L-train riders walking and biking is enjoyable and necessary.	☆	△ △
The NYC DOT and MTA should create a bus only lane on bridges entering Manhattan in the morning and leaving Manhattan in the evening.	☆	△
Create priority lanes on the bridges into Manhattan in the morning for vehicles with high numbers of passengers.	☆	△

☆	low	△	low feasibility
☆ ☆	medium	△ △	medium feasibility
☆ ☆ ☆	high	△ △ △	high feasibility

ACKNOWLEDGEMENTS

THE CORNELL UNIVERSITY DESIGN AND ENVIRONMENTAL ANALYSIS (DEA) 5560 HEALTH IMPACT ASSESSMENT SPRING 2017 STUDENTS/AUTHORS:

Chloe Collins, Hannah Dorpfeld, Katharine Guan, Sarah Lee, Janine Mazur, Kishore Seetharaman, Michal Segal, Krishna Shah

We would like to thank the following individuals for their guidance, time, and input throughout the HIA process:

NYC Partners / Sponsors

First, we want to express our gratitude to Andrew Brown of the Van Alen Institute for being an outstanding partner throughout the semester. Andrew helped to plan the HIA workshop, managed the logistics for the HIA workshop, and ensured that we had everything we needed for a successful workshop. He also attended a DOT workshop with us.

Thanks to the Van Alen Institute for partnering with us, suggesting that we study the L-Train shutdown, sponsoring this project, providing the venue for our stakeholder workshop, and funding our 2-day visit to New York City. We are grateful to have had this opportunity.

Participants in HIA Stakeholder Workshop

Brooklyn and Manhattan residents/ L-Train riders
Aman Bardia; Ruth Cole; Anjali Fisher; Ann Guiney; Dan Tainow; Marcus Wilford

Organizational / Stakeholder Representatives

Katelyn Hosey, Live-On
Lindsey Realmuto, New York Academy of Medicine
Kimberly Libman, New York Academy of Medicine
Luc Nadal, The Institute for Transportation and Development Policy (ITDP)
Homer Hill, Grand Street Business Improvement District
Marina Recio, Measure of America
Thomas DeVito, Transportation Alternatives

ADVISORY BOARD MEMBERS:

We are very grateful to our advisory board members who generously shared their time and wisdom with us. This group represents a wide range of fields including: Public Health, Environmental Psychology, and Urban Planning and expertise in environmental effects on health, health impact assessment, commuter stress, and the planning process.

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INTRODUCTION

THE L-TRAIN SHUTDOWN

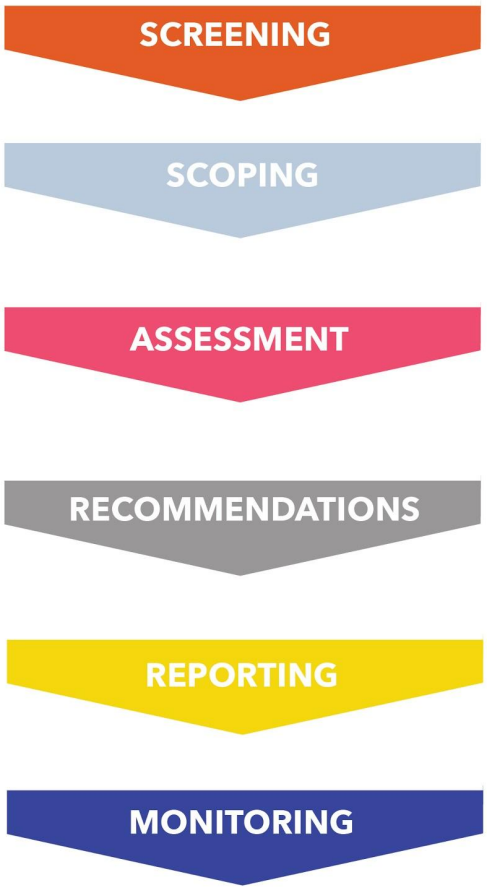
The L-Train is located in mid-Manhattan and runs crosstown, connecting city boroughs of Manhattan and Brooklyn. It has a weekday ridership of **400,000 commuters** (Cook, 2017). In 2012, Superstorm Sandy hit much of the northeast, devastating the Canarsie tunnel, through which the L-line runs under the East River. There was salt water damage to the tunnel and equipment. In the wake of the storm, the Metropolitan Transit Authority (MTA) has declared a fteen-month shutdown of the L-line between Manhattan and Brooklyn, and within Manhattan for repairs to the tunnel (Cook, 2017). The shutdown will begin in 2019 and will leave hundreds of thousands of passengers and daily commuters looking for other routes (Weinstock, 2016). This re-routing could have a wide spectrum of potential **health impacts** on Brooklyn and Manhattan residents and passengers.

The students of DEA 5560: Health Impact Assessment in the Department of Design & Environmental Analysis at Cornell University conducted this HIA to examine the potential health impacts of the L-train shutdown on the citizens of the affected boroughs. This report is meant to contribute to decision making which promotes health and equity in NYC.

WHAT IS AN HIA?

Health Impact Assessment (HIA) is “a combination of procedures, methods and tools by which a **policy, programme or project** may be judged as to its potential effects on the health of a population, and the distribution of those effects within the population” (WHO, 2017). An HIA is an increasingly popular method for bringing human health impacts to the forefront when discussing public policy and **decision-making** (Bhatia, 2011). HIA’s seek to provide decision makers with recommendations and suggestions to **enhance** the potential **positive health impacts** and **mitigate** or eliminate the potential **negative health impacts** of a project or plan (Health Impact Partners, 2011). HIA’s attempt to assess and consider the magnitude of a broad range of health determinants is becoming more widespread in the U.S.. This emerging process considers democracy, equity, sustainable development, the ethical use of evidence, and a comprehensive approach to health (Bhatia, 2011).

STEPS OF AN HIA



Determine whether an HIA is needed and likely to be useful.

Create a framework of the HIA, identifying the potential risks and benefits. Develop a plan for the HIA.

Describe the baseline health of the affected communities and **analyze the health impacts** using various experience and resources.

Develop practical strategies that can be implemented to mitigate health risks and amplify health benefits.

Disseminate the findings to decision makers, affected communities, and other stakeholders.

Monitor the changes in health or health risks and evaluate the efficacy of the measures that are implemented and the HIA process as a whole.

WHY DO AN HIA?

Human health should be considered in all major public plans, projects, and policies. HIA's assess a wide range of potential health consequences, typically before a decision has been made. HIA's can serve to increase the democracy, equity, and transparency in the decision-making process (Health Impact Partners, 2011). The L-Train shutdown could have **far-reaching consequences** on a large number of people (Cook, 2016). Although the decision to shut down the L-train has been made, it is important to consider the potential magnitude of the effects of the L-train shutdown on **human health**.

1. SCREENING

Determine whether an HIA is needed and likely to be useful.

SCREENING

WHAT IS SCREENING?

Screening, the first step of the HIA process, determines if an HIA would add value to the decision-making process. During this step, HIA teams assess the feasibility of the HIA given the resources and timeline available.

At this point our team considered factors that would affect the HIA:

- the potential that the L-train shutdown will have effects on health
- possible unequal impacts on vulnerable populations
- impacts on populations with existing poor health conditions
- the potential for the HIA to present substantial new information and considerations for mitigation of the shutdown

This HIA is slightly different than the traditional HIA in that the decision to shut down the L-Train has already been made by the Metropolitan Transit Agency (MTA). As early as January 2019 the L-train will be shut down for repairs to the Canarsie Tunnel. The decision to shut down the tunnel for 15 months is already set, with a projected cost of $300 million to the tunnel. The role of an HIA in this case is not to impact the decision, but instead to mitigate negative health impacts and to amplify positive health impacts of the L-Train shutdown through recommendations to the process leading up to, during and after the shutdown.

TIMELINE FEASIBILITY

The L-train shutdown is scheduled to commence in January 2019. With just under two years until the start of the project, there is sufficient time to complete an intermediate Health Impact Assessment (HIA) that will have an impact on policy decisions. Our HIA will be conducted over the course of the Spring of 2017. While the decision to shut down the L-train has already been made, this time could be used invaluably for the sake of analyzing both the positive and negative health impacts of the shutdown. We hope that by identifying these pros and cons, this information can be used to develop measures that amplify the positive health impacts and mitigate the negative impacts.

AVAILABLE RESOURCES

Our team consists of eight students enrolled in a three credit, 15 week class. The team includes undergraduates and graduate students from a variety of disciplines. They were aided by an advisory board of established professionals. Our partner and sponsor for the HIA is the Van Alen Institute in New York City. They serve as our primary client contact for our various stakeholders. They are committed to upholding their organizational values and have substantial buy-in to the HIA efforts.

We held a stakeholder workshop in New York City at the Van Alen Institute and invited the following: MTA, NYCDOT, The Station Alliance, Queens/Brooklyn Community Board, L Train Coalition, Transit Center, Live-On NYC, New York Academy of Medicine, the Institute for Transportation and Development Policy, the Grand Street Business District, Measure of America, Transportation Alternatives, State Senator Daniel Squadron, and Council Member Antonio Reynoso.

AUDIENCE

Riders and users will be receptive to bringing the conversation away from one that is financial and logistic, to include health. Given the decision to shut down the L-train has already been made, our HIA recommendations are limited to mitigation solutions. It is ultimately in the public and the decision makers best interest to address any public health concerns and potential harmful outcomes prior to the shutdown. Our recommendations will be presented to Department of Transportation and Van Alen Institute. They will receive our HIA and make decisions on implementation.

PUBLIC HEALTH

We believe this project has the potential to bring a new health perspective to the L-train shutdown. The planners at BRT planning international have already worked on assessing some potential impacts that the L-Train shutdown may have on the NYC commuters. However, health implications have not been addressed. Therefore, it is crucial to ensure that all stakeholders are made aware of the significant potential implications for health linked to the commute changes. Thus, an HIA for the L-train shutdown brings attention to how these changes affect commuters' physical, mental, and emotional well-being.

HEALTH RISKS & BENEFITS

The L-Train shutdown is likely to include both risks and benefits for human health. An intermediate Health Impact Assessment would reveal these risk and benefits, helping policy makers to mitigate the health risks and amplify the positive health benefits. Further research and examination will reveal more clearly what the risks and benefits are, but preliminary considerations suggest that some potential risks are likely to include:

- longer commutes could increase stress to individuals and limit their discretionary time, thus reducing their capacity to follow through with personal exercise plans
- increased stress from having to navigate a new and longer commute to work
- increased anxiety from overcrowding on alternative transportation options
- increased symptoms of depression from longer commutes cutting into leisure time
- decrease in physical activity as the shutdown will make some walking routes overcrowded and make other routes too long to include walking

While it is likely that there will not be many positive health impacts of the shutdown, the following benefits are possible:

- increased use of alternate commuter routes may include added walking time, adding a health benefit of exercise that was not previously included in their current transit routes
- repairing the damaged section of the Canarsie Tunnel, prevents future transportation hazards likely to cause injury or death to L-train users.

Beyond these few potential benefits, the HIA as a whole will highlight how such large scale changes affect commuters' physical, mental, and emotional well-being. Thus, this HIA would potentiate positive health impacts both for the L-Train shutdown and for future projects by bringing health to the decision making table.

2. SCOPING

Create a framework of the HIA, identifying the potential risks and benefits. Develop a plan for the HIA.

SCOPING

WHAT IS SCOPING?

The plan for the rest of the HIA is formulated during the scoping step. This includes identifying which areas, or determinants of health, need to be evaluated. Additionally, a framework, timeline, and method by which each task will accomplished are decided upon.

SCOPE OF THIS HIA:

Examining the L-Train shutdown, there are many determinants of health that could be impacted by the L-Train shutdown. In a broader sense, behavioral risk factors, environmental stressors, mobility, health related behaviors, employment and livelihood, and family and community structure would be affected by the shutdown. Figure 1 shows potential sectors the L-train shutdown may affect.

Figure 1: *Map of the L-Train Shutdown (Source: The New York Times)*

VULNERABLE POPULATIONS:

The shutdown of the L-Train can pose significant problems for key disenfranchised populations, including people with low-income, disabled individuals, elderly, and children.

Among the disenfranchised populations identified through the Screening process, the households with low-income have been identified as the key vulnerable population to focus for this HIA. **Low-income populations would not have the financial resources to cope with the impacts of the L-Train shutdown.** According to a geographical analysis of the neighborhoods in Brooklyn, approximately 18,889 low-income households are estimated to be relying on the L-Train service (Misra, 2016). As analyzed in **Figure 2**, the neighborhoods near the L-Train represent some of the Brooklyn districts with higher poverty rate. The lighter color of the purple in the map indicates higher percent in poverty, which is dominant near the L-Train highlighted in grey. Accordingly, the high-poverty neighborhoods in Brooklyn are analyzed in **Figure 3** as: **South Williamsburg**, **Bushwick**, and **Brownsville**.

Disabled and elderly populations refer to those individuals who face difficulties with physical and mental health as a result of disability or age. For these populations, many limitations may exist in the extent to which they can perform certain operations, such as mobility.

Children and adolescents are also disenfranchised populations as they often possess fewer economic and social means, which lowers the autonomy by which they can operate. Their younger age also poses difficulties when it comes to accessing alternative modes of transportation, as legal restrictions may be in place.

Figure 2 (left). **Figure 3** (right). *Maps of the Poverty Status in Brooklyn Neighborhoods Affected by the L-Train Shutdown (Source: Mamata Akella for Carto).*

HEALTH DETERMINANTS:

There is a range of factors that can significantly impact the status of a person's health. These factors include behavior, employment and livelihood, family and community structure, housing, environmental quality, public services, and political factors.
Our HIA report focuses on five particular health determinants:

1. **Environmental Stressors:** noise, crowding, air quality
2. **Mobility:** walkability, wayfinding, disability access, transportation hazards
3. **Health-related Behaviors:** physical activity, diet, sleep
4. **Employment and Livelihood:** access to jobs and occupational stress
5. **Family and Community Structure:** family dynamics, civic engagement, leisure

Developing upon the initial scoping, **frameworks** for the health determinant focused on in this HIA are presented in the following pages; one for each of the five health determinant categories. Frameworks illustrate the pathways from the L-Train shutdown to health effects. **Table 1** offers a summary on the relevant health determinants affected by the L-train shutdown and assessed in this HIA.

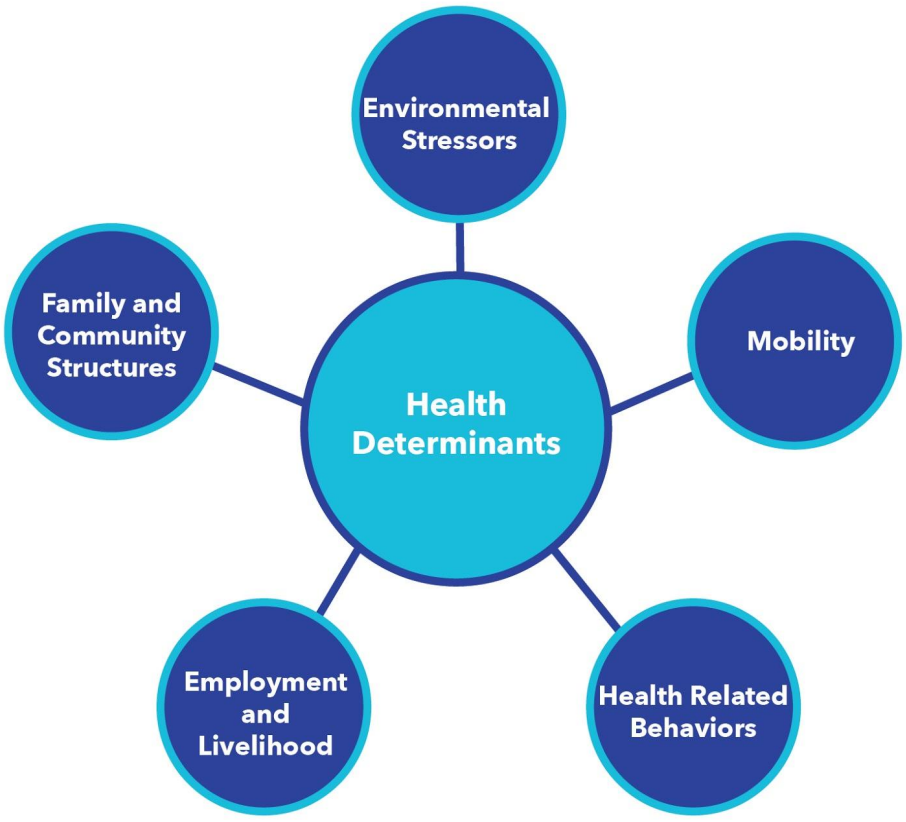


Figure 4 *Health Determinants*

Table 1: Sectors Affected by L-train Shutdown		
Sector	**Health Determinant**	**Relation to L-train Shutdown**
Behavioral	Diet Physical Activity/ Inactivity	• With less leisure time due to longer commutes there could be an effect on nutrition habits • With less leisure time there may be a decrease in voluntary physical activity • With the L-Train shutdown many commuters will have additional walking, individuals may get more physical activity added to their daily routine • The shutdown of the L-Train may prompt more individuals to walk or bike to work • Individuals may decrease cross-borough recreational interactions
Employment + Livelihood	Employment + Job Security Workplace Satisfaction + Control	• Longer commutes may lead to more anxiety at work which in turn may affect their work performance • Longer commutes may cause more absences or lateness at work leading to tension at work and perhaps loss of employment • Lengthening of commute may force employees to change job locations • Cognitive Overload
Family Structure	Family Structure + Relationships	• Less time at home due to long commutes could place tension on familial relationships including; anxiety, less family cohesion, less time for family traditions, marital tension, etc.
Community Structure	Social Support + Isolation	• Less time and energy could lead to less social support and isolation because individuals have less time to participate in community service, worship, and leisure activities. • With crowding on transit paths, crimes such as; theft, threats, and aggression may become more common.
Environmental Quality	Noise Transportation Hazards	• Reconstruction of the L-Train tunnel may cause transportation hazards and high noise levels.
Public Service	Educational Access Healthcare Access Parks and recreational centers	• Access to and convenience of these public services may be disturbed or diminished by altered transit routes. • Citizens may need to develop a new cognitive map to access public services
Housing	Housing supply, cost and accessibility Neighborhood infrastructure and livability	• Residents' housing market in Brooklyn may suffer and see a decrease in net worth due to L-Train shutdown • Livability may decrease due to lack of convenience and interruption of connection to Manhattan

In the frameworks that follow, there are sections titled "direct impacts," "mediators," "environmental stressors" and "behavioral impacts." These will be grouped together for the rest of the HIA and collectively referred to as "Health Impact Pathways". The "health impacts" section in the framework will be referred by the same term "Health Impacts."

FRAMEWORK - ENVIRONMENTAL STRESSORS

The following diagram provides a framework for our assessment and proposed hypotheses of the effects of the L-train shutdown on environmental stressors.

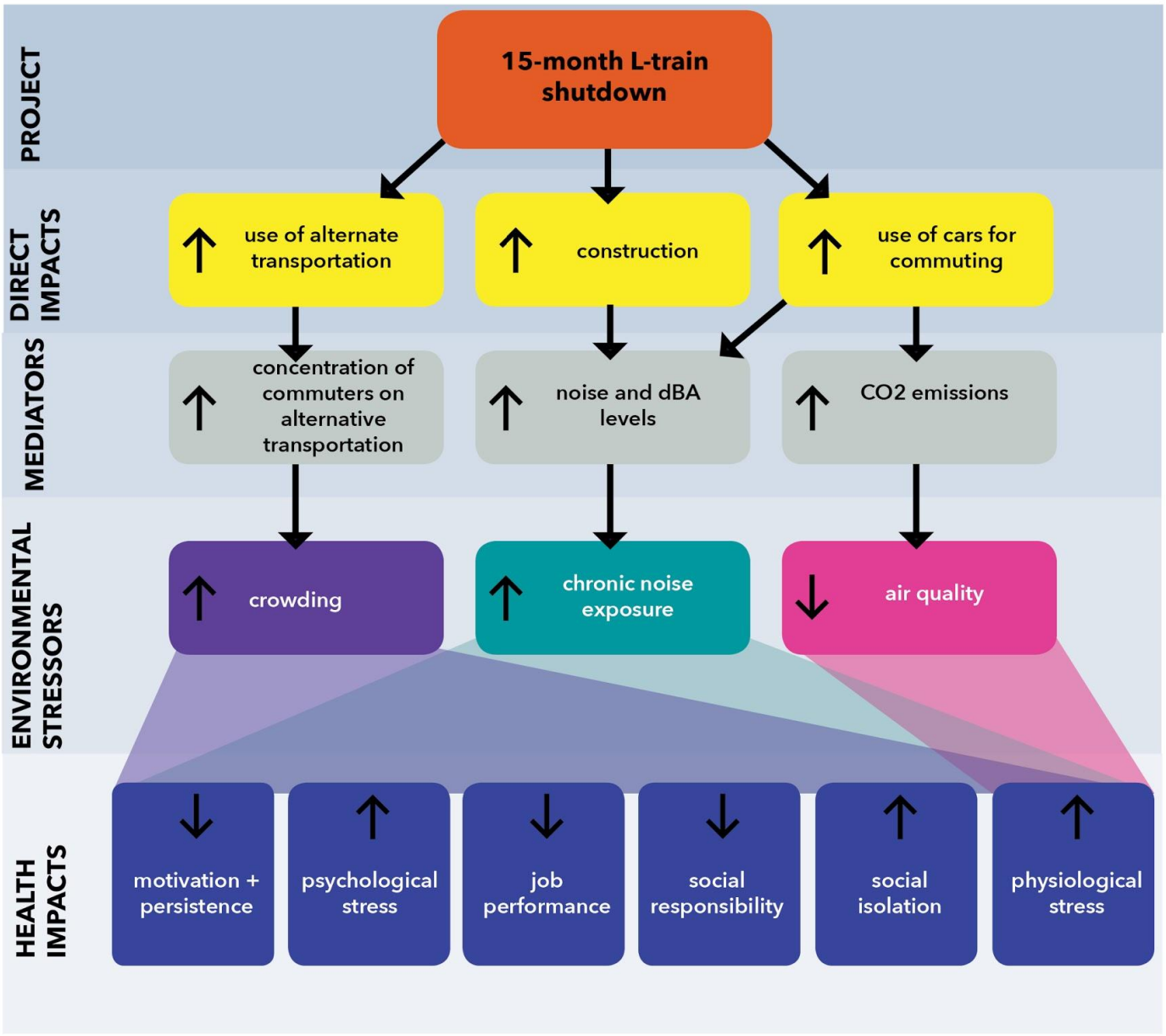


Figure 5 *Environmental Stressors Framework*

FRAMEWORK - MOBILITY

The following diagram provides a framework for our assessment and proposed hypotheses of the effects of the L-train shutdown on user mobility.

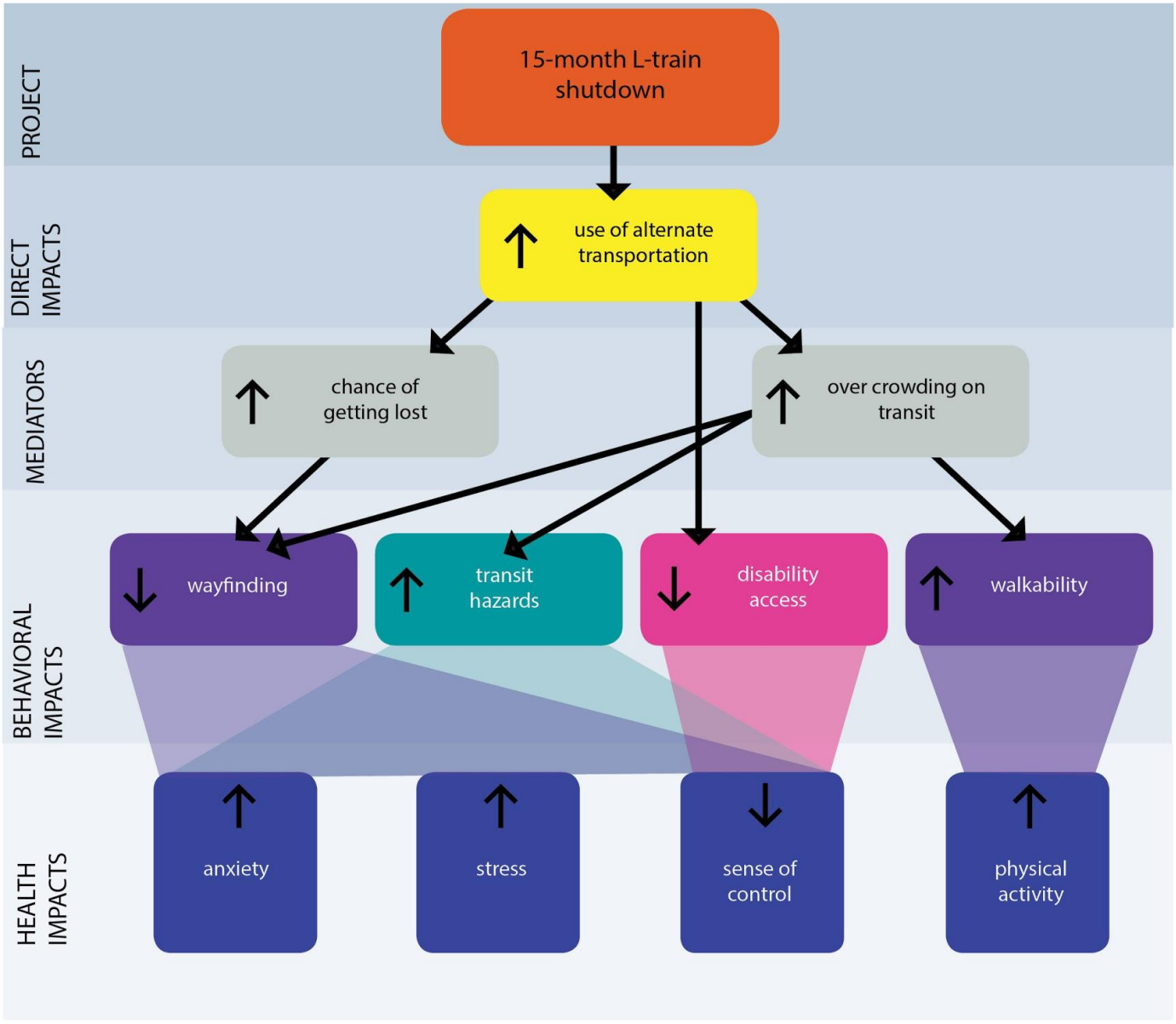


Figure 6 *Mobility Framework*

FRAMEWORK - HEALTH RELATED BEHAVIORS

The following diagram provides a framework for our assessment and proposed hypotheses of the effects of the L-train shutdown on health related behaviors.

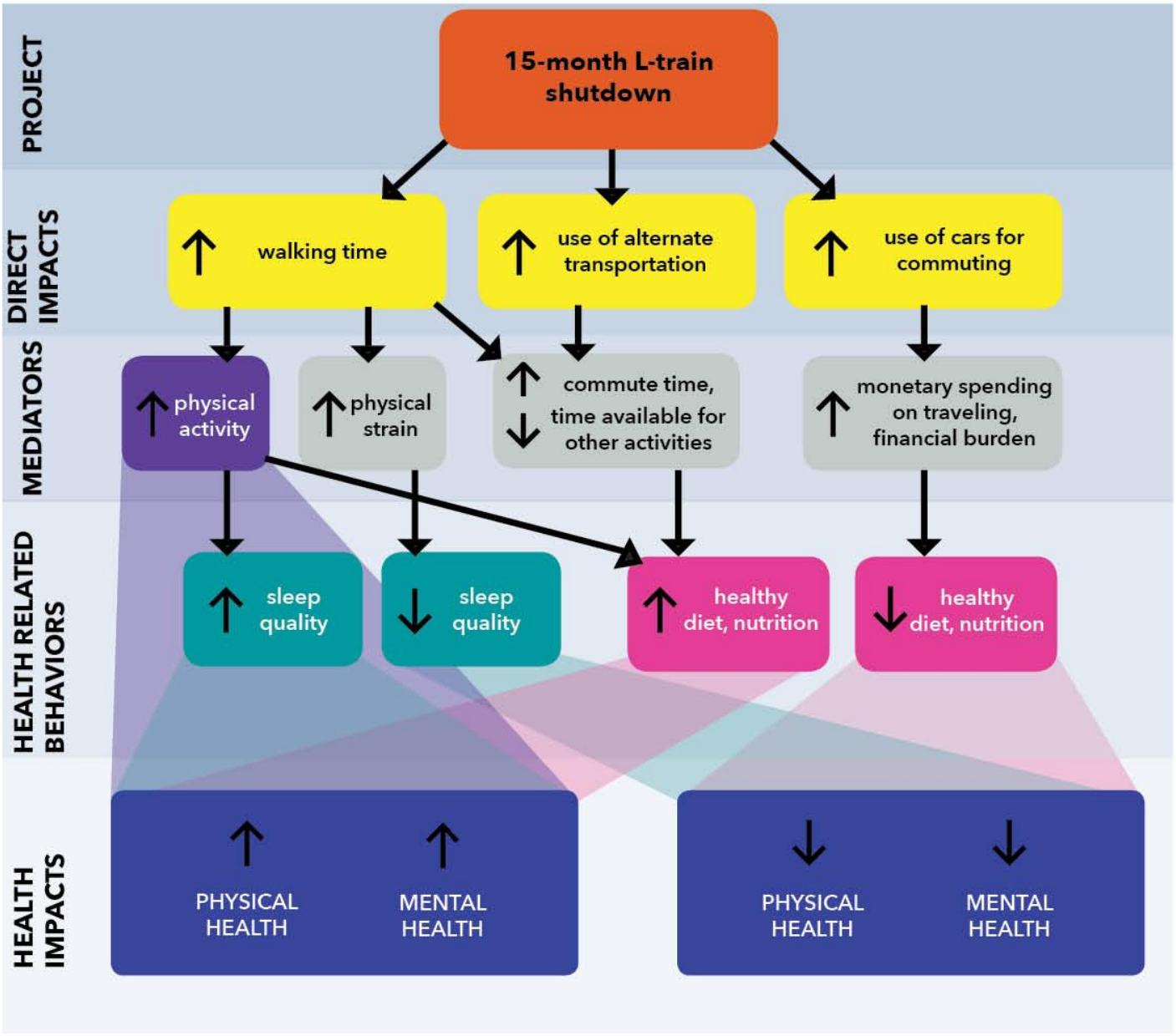


Figure 7 *Health Related Behaviors*

FRAMEWORK - EMPLOYMENT AND LIVELIHOOD

The following diagram provides a framework for our assessment and proposed hypotheses of the effects of the L-train shutdown on employment and livelihood.

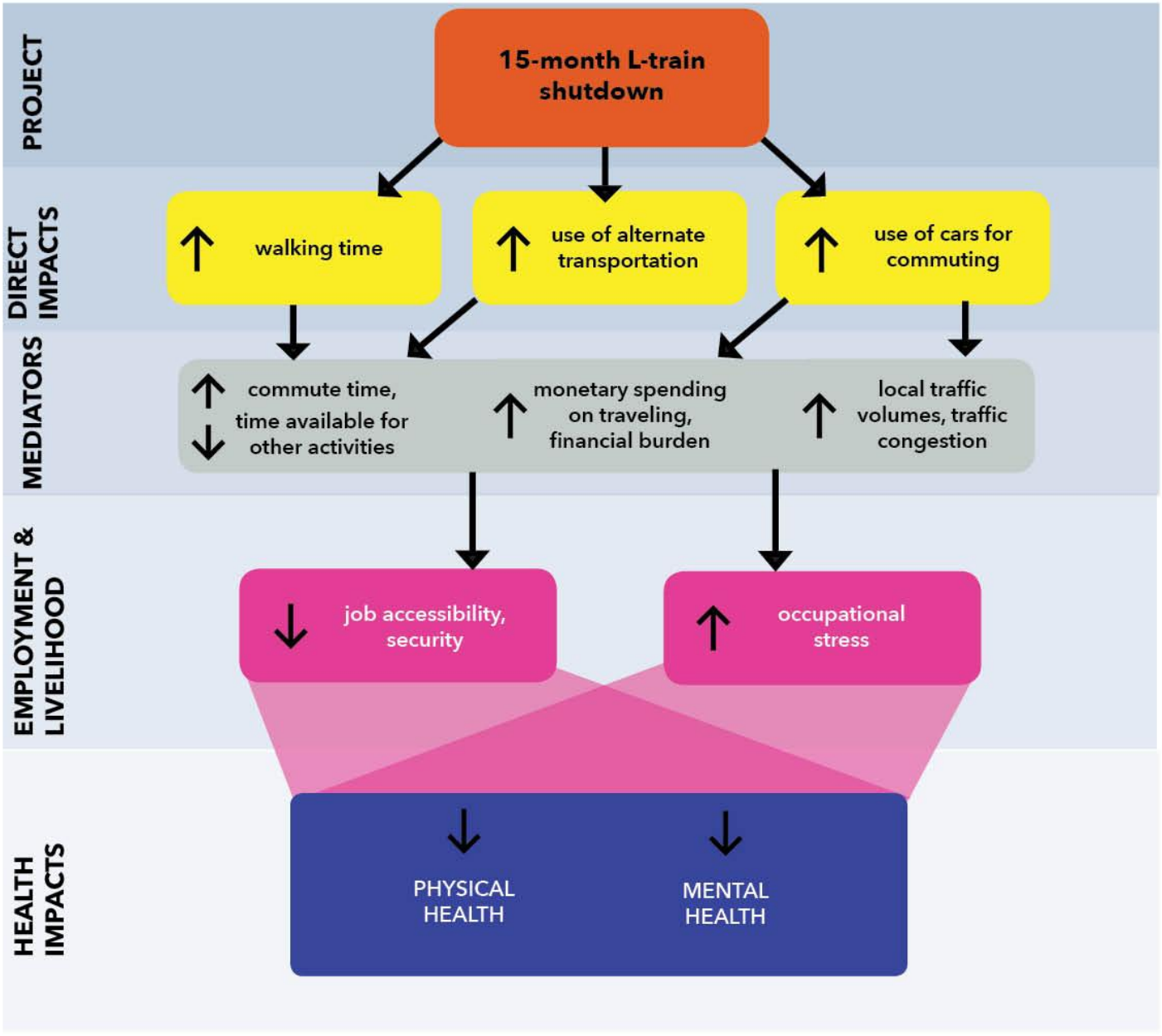


Figure 8 *Employment and Livelihood*

FRAMEWORK - FAMILY & COMMUNITY STRUCTURE

The following diagram provides a framework for our assessment and proposed hypotheses of the effects of the L-train shutdown on family and community structure.

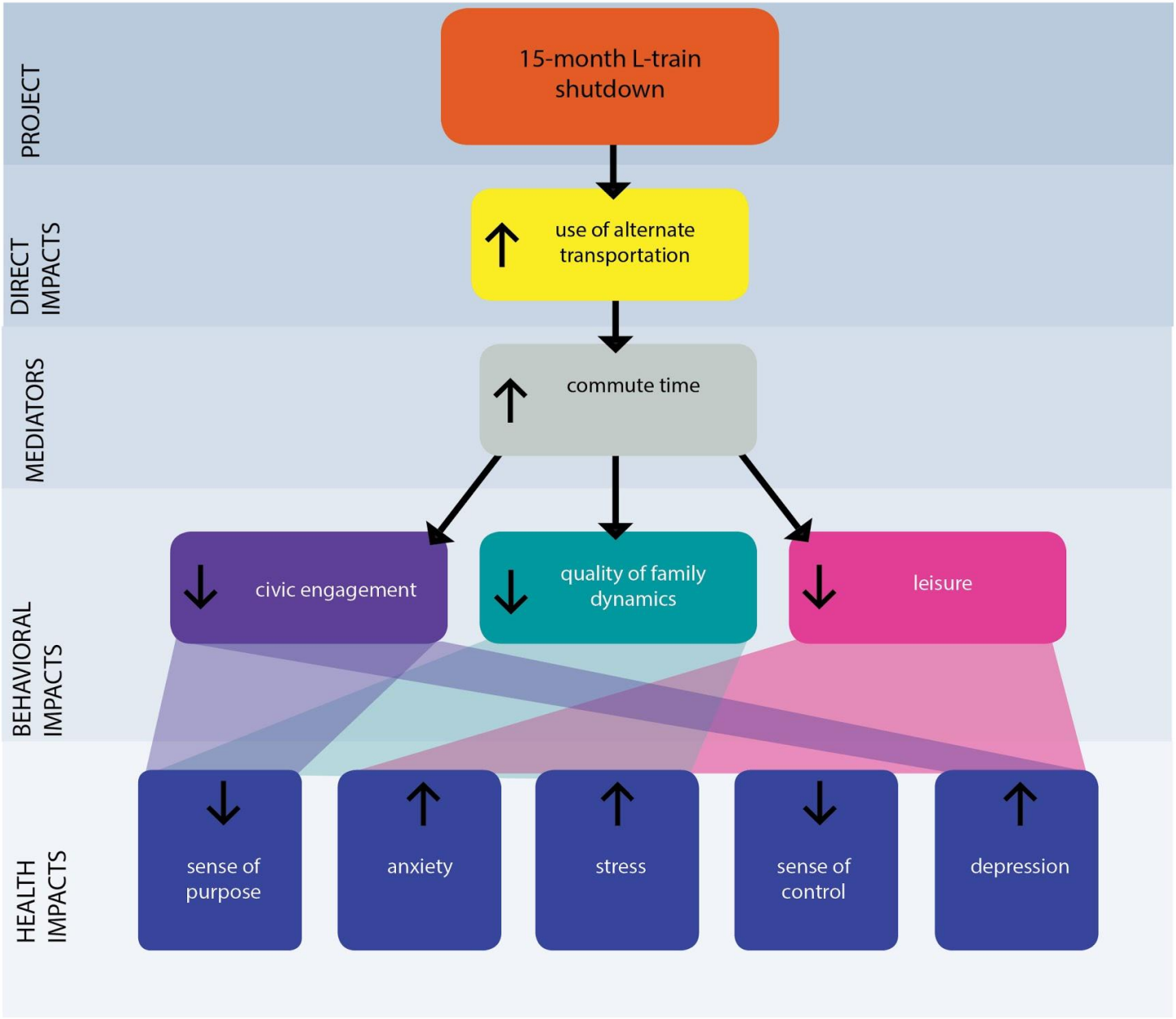


Figure 9 *Family & Community Structures Framework*

OUR RESEARCH METHODS

Our research was conducted through the use of relevant case studies, journal reviews, and articles. Additionally we had one on-site trip where we attended an MTA/DOT workshop and held our own stakeholder workshop.

LITERATURE REVIEWS

The stakeholder workshop was used to gain an understanding of the range of concerns that different organizations have concerning the L-train shutdown. In order to assess potential health impacts of the L-Train shutdown on Brooklyn residents we looked at baseline health conditions in Brooklyn districts and the impacts of environmental stressors, walkability, physical activity, diet, and sleep on human health. This overview of literature and demographics gives us greater insight on how the shutdown may have a wide array of factors influencing health in complex and unexpected ways. Separate literature reviews were conducted for the following topics: Crowding, Noise, Walkability, Physical Activity, and Diet. Complete literature reviews of these topics can be found in the appendix.

STAKEHOLDER WORKSHOP

The DEA 5560 Health Impact Assessment Team held a stakeholder workshop in New York City at the Van Alen Institute and invited the following: MTA, NYCDOT, The Station Alliance, Queens/Brooklyn Community Board, L Train Coalition, Transit Center, Live-On NYC, New York Academy of Medicine, the Institute for Transportation and Development Policy, the Grand Street Business District, Measure of America, Transportation Alternatives, State Senator Daniel Squadron, Council Member Antonio Reynoso, and several Brooklyn and Manhattan L-train riders. The following entities were invite but unable to attend: MTA, NYCDOT, The Station Alliance, Queens/Brooklyn Community Board, Transit Center, Daniel Squadron, and Antonio Reynoso.

Figure 10 *Workshop conducted at Van Alen Institute, New York*

STAKEHOLDER WORKSHOP

During the workshop, stakeholders identified potential benefits and potential risks of the L-Train closure and brainstormed strategies to ease the stress of the closure. Below is a list of the top three benefits, risks, and strategies identified during the workshop.

TOP 3

BENEFITS

- Improvements to alternative transportation, including ferries, buses, carpools
- Better commuter benefits, fair fares
- Increase in physical activity

RISKS

- Stress
- Employment and financial stability
- Increased social isolation

STRATEGIES

- Incentivize bicycling, increase safety
- Early communication of new routes/online consolidation for information/updates
- Bus priority lanes/rapid bus transit

Figure 11 *Definitions of Health as identified by attendees of workshop*

3. Assessment & Recommendations

Describe the baseline health of the affected communities and analyze the health impacts using various evidence and resources.

Develop practical strategies that can be implemented to mitigate health risks and amplify health benefits.

ASSESSMENT & RECOMMENDATIONS

WHAT IS ASSESSMENT?

The assessment phase identifies baseline health conditions and characterizes expected health impacts. Essentially, assessment examines the health effects that may occur as a result of the project at hand (Bhatia et al., 2011). Assessment is the core of an HIA and serves as the bulk of the study. It involves close study of affected populations and the possible health outcomes.

The impact of the L-Train shutdown will be assessed in a series of steps. Baseline data will be collected for the three Brooklyn neighborhoods identified in scoping - Bushwick, Williamsburg, and Brownsville. This data will be related to the two health determinants identified, health-related behaviors and employment and livelihood. Finally, the impact of the shutdown on these categories will be examined. A variety of populations will be examined, including adults, elderly, disabled, and children.

WHAT ARE RECOMMENDATIONS?

Recommendations include designing strategies/alternatives to improve and protect health. Additionally, stakeholder input is used to prioritize recommendations in order to develop a health management plan that that takes into account the needs of the stakeholders, the feasibility of the recommendations, and the cost-effectiveness of the proposed strategies (Bhatia et al., 2011).

Recommendations for the L-Train Shutdown entail the strategies and suggestions for mitigating the health risks that can result from the major subway line shutting down for 15 months. As a synthesis of the assessment of the impact of L-Train shutdown on health, on the following page, the table provides recommendations to promote the positive and mitigate the negative health impacts of the L-Train shutdown. Recommendations are based on the research evidence and discussions with stakeholders of the affected community.

BASELINE HEALTH CONDITIONS: COMMUNITY PROFILE

The following Brooklyn districts may be affected by the shutdown as the L-train line passes through or neighbors them: Williamsburg, Brownsville, Bushwick, Queens (Ridgewood & Glendale), East New York, Canarsie and Bedford-Stuyvesant. While all of Brooklyn may be affected by the shutdown, these boroughs will receive a more direct impact due to their adjacency to the L-train line. While Brooklyn's racial, ethnic and socioeconomic diversity is fairly distributed throughout the borough, health and economic inequalities and disparities emerge when comparing districts within the borough (Durkin, 2015). The districts described in the following tables may receive compounded effects from the shutdown due to their current health and socioeconomic conditions.

Table 2: % of Populations by Age

	Williamsburg	Brownsville	Bushwick	Ridgewood	East NY	Canarsie	Beford-Stuyvesnt
0–17	23.0	29.0	25.0	22.0	28.0	24.0	25.0
18–24	11.0	12.0	13.0	9.0	12.0	10.0	12.0
25–44	40.0	27.0	34.0	32.0	27.0	26.0	32.0
45–64	17.0	22.0	20.0	26.0	23.0	28.0	22.0
65+	9.0	10.0	8.0	12.0	11.0	12.0	10.0

Table 3: Baseline Data on Brooklyn Demographics

	Williamsburg	Brownsville	Bushwick	Ridgewood	East NY	Canarsie	Beford-Stuyvesnt
% Hispanic	27.0	20.0	65.0	36.0	37.0	9.0	20.0
% Black	5.0	76.0	20.0	1.0	52.0	60.0	64.0
%White	61.0	1.0	9.0	54.0	3.0	26.0	11.0
%Asian	6.0	1.0	5.0	8.0	6.0	4.0	2.0
%Other	1.0	2.0	1.0	1.0	2.0	2.0	2.0
% Foreign Born	24.0	30.0	37.0	38.0	35.0	41.0	19.0

HEALTH STATUS

Among districts most directly affected by the shutdown (Williamsburg, Brownsville, Bushwick, Ridgewood, East New York, Canarsie and Bedford-Stuyvesant) life expectancies in Bushwick, Brownsville and Ridgewood are the lowest (74.1-78.7 years) in Brooklyn and parallel to rates in Washington Heights. There is a significant difference between these and surrounding boroughs, the highest life expectancy in the five boroughs being 85.4 years. Asthma, cardiovascular disease, HIV/AIDS and diabetes are examples of health condition rates that are particularly higher in Brownsville, East New York, Canarsie and Bedford-Stuyvesant districts. Other health indicators such as child mortality rates show similar health disparities between districts (NYC Health, 2015). The top causes of death within these particular districts include heart disease, cancer, Diabetes Mellitus, stroke, flu/pneumonia and respiratory diseases (NYC Health, 2015). Brownsville, East New York, Canarsie and Bedford-Stuyvesant 15% or above of the population are diagnosed with diabetes.). Brownsville, East New York, and Bedford-Stuyvesant have significant mental health crises, ranking 2nd, 10th and 8th citywide for psychiatric hospitalizations.

Table 4: Baseline Data on Brooklyn Community Health

	Williamsburg	Brownsville	Bushwick	Ridgewood	East NY	Canarsie	Beford-Stuyvesnt
Average Life Expectancy (years)	80.2	74.1	78.8	81.0	77.7	81.3	75.1
% Citizens' Physical Activity in Last 30 Days	76.0	79.0	74.0	77.0	73.0	74.0	76.0
Obesity Rate	24.0	32.0	28.0	21.0	28.0	32.0	33.0
% Population Diagnosed With Diabetes	10.0	15.0	13.0	7.0	18.0	15.0	15.0
HIV Diagnoses/ 100,000 Pop.	20.3	66.0	36.8	14.7	41.3	22.3	64.1
Infant Mortality Rate/ 10,000 Live Births	3.4	8.0	5.0	3.4	5.0	5.6	5.0
Hospitalizations due to stroke (per 100,000 adults)	293 (ranks 33rd citywide)	413 (ranks 10th citywide)	470 (ranks 1st citywide)	259 (ranks 42nd city-wide)	414 (ranks 9th citywide)	344 (ranks 20th city-wide)	415 (ranks 8th citywide)
Psychiatric hospitalizations (per 100,000 adults)	466 (ranks 40th citywide)	621 (ranked 6th amongst	740 (almost twice citywide rates)	148 (ranks 38th citywide)	389 (ranks 15th citywide)	192 (ranks 34th citywide)	531 (ranks 10th citywide)
Hospitalizations for adult asthma (per 100,000 adults)	18 (half city-wide rates)	61 (almost twice citywide rates)	70 (ranks 9th citywide)	18 (ranks 38th citywide)	50 (ranks 18th citywide)	29 (ranks 26th citywide)	604 (ranks 8th citywide)
Hospitalizations for child asthma (per 100,000 child, ages 5-14)	18 (half city-wide rates)	61 (almost twice citywide rates)	70 (ranks 9th citywide)	18 (ranks 38th citywide)	50 (ranks 18th citywide)	29 (ranks 26th citywide)	54 (ranks 16th citywide)
Hospitalizations for adult diabetes (per 100,000 adults)	276 (lower than overall Brooklyn rate)	748 (highest rate citywide)	582 (ranks 9th citywide)		539 (ranks 10th citywide)	352 (ranks 23rd citywide)	604 (ranks 8th citywide)

ECONOMIC STATUS

Brooklyn has an overall unemployment rate of 4.5% according to 2013 census data. Within the borough's census tracts, unemployment rates were at least 50% higher in certain areas including Brownsville, Bushwick, Bedford-Stuyvesant and East New York areas (DiNapoli & Bleiwas, 2014). Household Income of Brooklyn remains significantly lower than that of Manhattan with Brownsville, East New York and Bedford-Stuyvesant poverty rates ranging especially high. The average commute from any of the affected Brooklyn districts ranges from about 36 to 48 minutes.

Table 5: Socioeconomic Baseline Data

	Williamsburg	Brownsville	Bushwick	Ridgewood	East NY	Canarsie	Beford-Stuyvesnt	Brooklyn Total
Total Population	176,937	86,377	114,134	114,134	183,971	197,211	154,332	2,636,735
Poverty rate	26.5	37.0	28.5	17.1	36.0	11.4	30.7	22.3
% Child poverty	58.7	42.9	13.3	0.9	16.7	4.5	42.2	14.1
% Unemployment	7.0	16.0	16.0	9.0	16.0	11.0	17.0	5.9
% workforce population, female, 16+ years	----	----	----	----	----	----	----	58.7
% Limited English Proficiency	24.0	9.0	33.0	23.0	16.0	15.0	13.0	---
Median HH Income	----	----	----	----	----	----	----	$48,201
Avg. Persons per HH	----	----	----	----	----	----	----	2.74
Average commute time to work (minutes)	36.2	48.2	40.3	39.4	44.8	48.1	41.9	---

ENVIRONMENTAL STRESSORS

Environmental stressors are stimuli in our environment that cause discontent or stress. Environmental stressors include: noise, air quality, and crowding. Stress can have physiological ramifications, such as: increased blood pressure, increased serum cortisol levels, increased risk of cardiovascular disease, decreased short-term memory, decreased immune functioning, and a myriad of other health effects (McEwen, 1998). Stress can also have psychological impacts including, but not limited to: anxiety, depression, social withdrawal, fatigue, and strained relationships (Regoeczi, 2003). Stress is cumulative, meaning that many environmental stressors can have magnified results when experienced together.

Certain population sub-groups may be vulnerable to multiple stressors. For example, individuals of a lower socioeconomic status (SES) are generally more likely to have more exposure to stressors, such as, poor housing quality, air pollution, chronic noise exposure, crowding, and low control jobs (Evans et al., 2002). These together often result in amplified impacts that one environmental stressor alone would not elicit.

NOISE

WHAT IS NOISE?

Noise is a psychological phenomenon. The brain may perceive unwanted sound or “noise” once picked up by the ear as unwanted and disturbing (Novotney, 2011). Noise is an environmental stressor that affects a large number of people, particularly in urban areas. Chronic noise exposure can have psychological stress effects, physical effects, and cognitive effects, such as, decreased task performance (Taffalla & Evans, 1997).

CURRENT CONDITIONS

- Vulnerable populations are more easily affected by environmental stressors. This is of particular concern to areas affected by the L-train shutdown such as Brownsville, East New York and Bedford-Stuyvesant.
- These three Brooklyn districts have vulnerable populations which show higher poverty rates, obesity rates and diabetes diagnoses. Additional stress at the beginning and end of the workday from commuting uncertainties, crowding, and noise may cause increases in cortisol levels which can lead to exacerbation of current poor health conditions.

HEALTH IMPACT PATHWAYS:

- When the L-train shuts down more people may use alternate modes of transportation including:
    - Buses
    - Sidewalks
    - Biking lanes
    - Cars
    - Taxis, Uber, Lyft, etc.
- With additional crowding on transit paths comes additional noise. The construction work in the Canarsie Tunnel could also add to the street noise for Brooklyn and Manhattan residents.

HEALTH IMPACTS:

- Chronic noise exposure linked to decreased motivation and persistence (Evans, Hygge, & Bullinger, 1995).
- Chronic noise exposure may lead to feelings of little control or helplessness (Cohen, 1980).
- Noise is correlated with negative psychological and behavioral impacts e.g. sleep deprivation, feelings of annoyance, low motivation and low attention levels (Evans, Hygge & Bullinger, 1995).
- Chronic noise exposure can have physiological effects (Taffalla & Evans, 1997).
- Prolonged exposure to stress can result in hearing loss, memory loss, increase in blood pressure level, heart disease and stroke (Bilotta, Vaid & Evans, 2017).
- Research subjects exposed to noise of approximately 85 dBA were less likely to engage in helping behavior than subjects exposed to lower noise conditions (Matthews et al., 1975).

VULNERABLE POPULATIONS

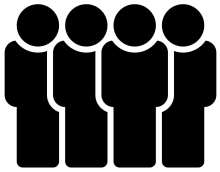
- Older adults- Hearing loss occurs more frequently with age.
- Youth- Young children are very susceptible to the effects of chronic noise.
- Low-income residents- Low income residents are more likely to be around noise and additional environmental stressors.
- Construction workers- Construction workers work with loud equipment which can affect their hearing.
- Individuals with disabilities- Pre-existing hearing loss and other disabilities may be amplified with chronic noise exposure.

RECOMMENDATIONS

In order to alleviate the physical/cognitive toll of chronic exposure to noise:

- **Limit construction noise** by using equipment with a Time Weighted Average of less than 85 dBA (OSHA).
- Employ **noise-cancellation techniques** in the new construction and repair of the current L-Train platforms and trains.

CROWDING



WHAT IS CROWDING?

Urban areas are prone to issues of crowding, which occurs when the space allotted contains too many people for comfort. There are many nuances in the definition for crowding, but generally it is important to note the distinction between crowding and density. Density is typically viewed as the number of people per given area, but crowding is a psychological construct based on perception (Boots, 1979).

CURRENT CONDITIONS

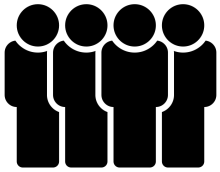
- Commuters from Brooklyn in job sectors which have prompt arrival times and physically demanding work, such as, healthcare, domestic, and construction will have additional stress placed on them due to longer, crowded commutes and may suffer poor performance on the job from stress carry-over.
- There are currently multiple senior citizen centers adjacent to the L-train subway line. Some of the residents of these homes rely on the L-train for daily living activities. Crowding of major commuting routes may intimidate vulnerable populations such as the elderly that are present in these neighborhoods.
- Social isolation is another concern that can result from overcrowding. This is a major health concern not only for mental health but also for nutrition and food security of residents of Williamsburg, Bushwick and Bedford- Stuyvesant. For these neighborhoods especially, social stimuli and overload could create barriers for the elderly or other individual's especially sensitive to overloads of social stimulation.

HEALTH IMPACT PATHWAYS:

- With the riders displaced from the L-Train, more people will flock to other trains or other forms of transportation. Crowding may become a concern at train stations, bus stops, as well as roads and sidewalks. There are many potential health impacts of chronic crowding.

HEALTH IMPACTS:

- Crowding on transit may cause increased stress levels, which can be linked to lower scores on proofreading tasks measuring motivation and persistence (Evans & Wener, 2007).
- Crowding linked to psychological stress which can manifest in aggression, social withdrawal, and isolation (Regoeczi, 2003).
- Crowding typically causes a decrease in altruism (Milgram, 1970).
- Individuals may use withdrawal mechanisms as a coping strategy when there is stimulus overload brought on by excess people or when feeling threatened. Individuals will “tune out” of social situations in effort to regain control in crowded scenarios (Regoeczi, 2003).
- Research shows people living in crowded situations have poorer memory for social information and details than their less crowded counterparts (Evans et al., 2000).



VULNERABLE POPULATIONS:

- Older adults - Older adults are prone to social withdrawal and isolation, which may be amplified by crowding.
- Youth- Crowding is a potent environmental stressor that may cause physiological stress with prolonged crowding.
- Low-Income residents- Low income residents are more likely to live in crowded housing conditions that are coupled with multiple environmental stressors such as: chronic noise exposure and poor air quality (Evans, 2004).
- Individuals with disabilities- Individuals that may already be susceptible to cognitive overload may experience worsened effects with crowding.

RECOMMENDATIONS:

Use nature as a buffer to improve physiological stress.

This can be accomplished by:

- Use graphics of natural elements and actual living natural elements on trains, buses, and subway stations to mimic the **healing properties of nature**.

Increase predictability in residents commuting experience by warning them of any delays or congestion. (Evans & Wener, 2007)

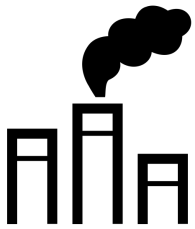
This can be accomplished by:

- Promoting a **free app** which will notify residents before and during commute to prepare for route changes.

In order to reduce the negative health impacts of crowding, allow for increased bus, car, bicycle, and foot traffic density in select places of transport to decrease crowding.

- This can be accomplished by:
- Improve **safety, routes, and scale of sidewalks** and bike paths to accommodate heavy and re-routed **foot and bike traffic.**

AIR QUALITY



WHAT IS AIR QUALITY?

The relative level of manmade and natural pollutants in the air distinguishes air quality (Air Quality [EPA], 2016). Poor air quality is an environmental stressor that often has lingering aftereffects. The elderly, low SES, individuals with asthma or existing respiratory disease, and children are particularly vulnerable to poor air quality (Evans, 2004).

CURRENT CONDITIONS

- According to the NYC Health website, based on pollution levels in 2009-10 particle (PM2.5) pollution caused an average of 2,000 deaths, 1,500 hospital admissions for lung and heart conditions and 5,000 asthma-related emergency department admissions (NYC Health, 2016).
- Populations that are particularly vulnerable are the very young, elderly and individuals with preexisting health conditions.
- Citywide levels of PM2.5 are ranged from 5.3 to 23.0 µg/m3 ((NYC Health, 2017). The background exposure to PM2.5 is 3–5 µg/m3 on a daily average in the U.S. and Western Europe. The European Commission has set an exposure reduction target of 18 µg/m3 by 2020 (European Commission, 2016). Exceedances of the current citywide levels of pollutants should be minimized as many of the districts affected by the L-train shutdown have populations diagnosed with asthma and respiratory conditions which are highly reactive to poor air quality.

HEALTH IMPACT PATHWAYS:

- Air quality is a pervasive environmental stressor that can have profound impacts on human health. The increased strain on the existing infrastructure with more cars and vehicles in the wake of the L-Train shutdown may increase the amount of harmful particulates and emissions in the air. This can particularly affect vulnerable populations such as: youth, older adults, construction workers, and people with pre-existing respiratory conditions.

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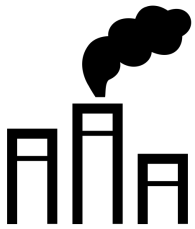
HEALTH IMPACTS:

- Low income households are particularly impacted as they often have higher incidences with nitrogen dioxide, radon, carbon monoxide and water pollution (Evans, 2004).
- Commuting increases exposure to noxious/toxic substances such as, volatile organic compounds (VOC's), carcinogens, nitrogen dioxide, sulfur dioxide, small particulates, resulting in increased risks of asthma, respiratory problems, and cardiovascular disease with prolonged exposure (Wener & Evans, 2011).
- Trees on the street have been shown to reduce early childhood asthma rates (Lovasi, 2008).



VULNERABLE POPULATIONS:

- Older adults - The effects of poor air quality may be cumulative, thus worsened with age.
- Youth- Young people have developing respiratory and immune systems, which may be harmed or stunted with poor air quality
- Low-Income residents- Low income residents face multiple environmental stressors, which amplify the effects of poor air quality and can result in harmful physiological health impacts.
- Individuals with disabilities- Pre-existing ailments such as, asthma and other respiratory diseases may be exacerbated by poor air conditions.

RECOMMENDATIONS:

Use nature as a buffer to improve physiological stress.

This can be accomplished by:

Plant shrubs and trees along roads and on street medians to provide a **buffer** between vehicles and the natural and built environments and reduce poor air quality effects on individuals with pre-existing asthmatic conditions (Lovasi, 2008).

In order to reduce the chance of respiratory problems, limit prolonged exposure to air pollution.

This can be accomplished by:

- Keeping the construction process transparent for city residents posting an **online reference list** that clearly indicates materials used in the **construction process** so that the avoidance of harmful materials can be encouraged.
- Provide signage and research **discouraging car use**, to decrease rates of air pollution. Cars should be limited to situations with **multiple passengers.**

MOBILITY

Physical mobility is the ability of humans to move about their environment. A person's physical mobility is an important influence on their ability to perform necessary, daily activities both inside and outside of the home. Physical mobility is impacted by many factors including: a neighborhood's walkability, the wayfinding tools in an area , the accommodations made to facilitate disability access, and the different types of transportation hazards present. The L-train shutdown will limit the ability of some residents and commuters to travel to some of their regular destinations.

WALKABILITY

WHAT IS WALKABILITY?

Walking is the simplest form of physical activity and the most basic form of transportation. Yet, only about half of American adults achieve the recommended 150 minutes a week of moderate-intensity aerobic physical activity (CDC, 2013). Walkability generally refers to how walkable an area is based on available amenities and ease of access, often depending on environmental design and physical attributes of an area (Leslie, et al. 2005). As popularity for walkability increases, metrics such as the Walk Score begin to measure the walkability of areas based on proximity to amenities, awarding maximum points for amenities within a five minute walk (0.25 miles) and no points after 30 minutes (Walk Score). In a study conducted in California and Oregon, transit users were on average willing to walk half a mile to their transit hubs (Agrawal, Schlossberg, and Irvin, 2008).

CURRENT CONDITIONS

- Areas around the L-train generally score high in walkability
- Certain pockets less walkable
    - Bushwick, low income neighborhood with few amenities
    - Greenpoint, mostly residential with few amenities

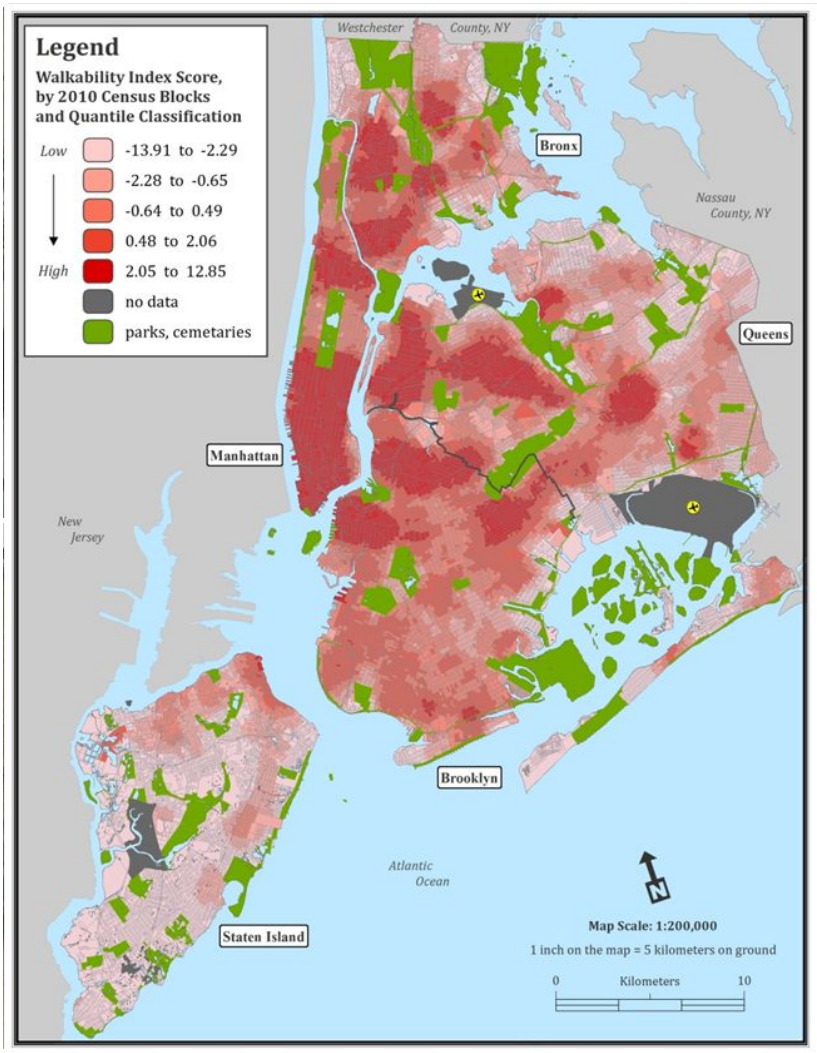


Figure 12:
https://beh.columbia.edu/2015/11/17/using-gps-and-accelerometers-to-study-neighborhood-walkability-and-physical-activity/

HEALTH IMPACT PATHWAY:

- While many parts of Brooklyn are already pedestrian friendly, the shutdown may encourage those who usually traverse Canarsie Tunnel to stay within Brooklyn.
- With the inconvenient closure, new events or opportunities may arise which can encourage more people to walk around Brooklyn.

HEALTH IMPACTS:

- If residents find themselves staying more locally, crowding may increase both on sidewalks and in the streets, which can increase stress and anxiety for vulnerable populations, such as older adults, those with physical disabilities, and children.
- Those who are physically able may benefit from more physical activity if enticed by more neighborhood activities.

VULNERABLE POPULATIONS

- Older people and people with disabilities may find it more difficult to navigate with more people on the streets.
- Children may also become disoriented with increased crowding.

RECOMMENDATIONS

- In order to mitigate potential crowding on the streets, MTA can work with Brooklyn and have planned **street closures** for pedestrians, allowing more space for people to walk and spread out.
    - MTA can take advantage of these closures to identify and partner with key organizations located in Manhattan and hold moving and/or temporary **pop-up events** in Brooklyn along the L-train or near key alternative transportation hubs. This can bring events to those who rely on the L-train to get to their social functions. Additionally, this can also promote organizations by taking advantage of increased pedestrians on the street.
- To mitigate potential stress from crowding for vulnerable populations, there can be designated **rest or waiting areas** for people to catch a breath before continuing on their route. These areas can be similar to bus shelters, offering shelter from the weather and having seats for people to sit; ultimately **prioritized** for older adults and people with disabilities.
- Additionally, MTA can partner with Brooklyn to install parklets around areas with high pedestrian traffic. **Parklets** can offer rest or waiting areas, as well as provide **greenery and nature** to help reduce stress from crowding.

WAYFINDING

WHAT IS WAYFINDING?

Wayfinding is how we navigate from place to place. It is an integral part of our everyday life, and allows us to accomplish all of the tasks in our daily routines. The human brain can navigate more easily when it has already registered a mental map of an area, and will develop a "cognitive map" either when looking at a physical map, or simply when traveling. For example, a person can create associations between landmarks and other distinct street images in order to remember a particular path. Essentially, cognitive maps allow routes to become second nature, and allow a person to gain comfortability with new paths.

However, when traveling novel routes, the brain's cognitive map is always evolving and must constantly be updated. An inability to easily develop new cognitive maps can lead to confusion, anxiety and cognitive fatigue (Allen 1999). Since the temporary shutdown of the L-Train will be a jarring disruption to the established cognitive maps of many Brooklyn residents, it is imperative to enhance wayfinding aids for the altered commutes.

Wayfinding can be enhanced through signs, road markers, directional signals, online information, lights, or other methods. Good wayfinding aids reduce the risk of getting lost and injured. They also increase the accessibility of certain neighborhoods, expanding a person's freedom in choosing where to live, which can set them at ease both mentally and emotionally (Hunter 2013).

However, while some of the stops on the L-train have easy access to various transfer subway lines, many other forms of transportation, like walking, biking, busing, driving, and taking the ferry will be inundated with more pedestrians and busy commuters. Naturally, it will become more difficult to navigate these changes in Brooklyn without either preexisting cognitive maps, or more importantly for tourists and other visitors, physical signage and wayfinding aids.

Color: indicates whether or not you can enter this station; green means yes

Writing: tells the pedestrian what station this is

Symbol: advertises what Subway line runs at this particular station

Figure 13: Various wayfinding tools

CURRENT WAYFINDING AIDS:

Maps and Signs:

- There are subway maps in every subway car, and on some platforms
- The DOT has installed street level totem signs at all Select Bus Services to provide real-time arrival times for buses. The totems also show the path and neighborhood that the bus moves through (WalkNYC, 2017).

Personal Technology:

- Apps like Google Maps, Transit, MyTransitNYC, Citymapper and more.

Figure 14: *Street Level Totems*

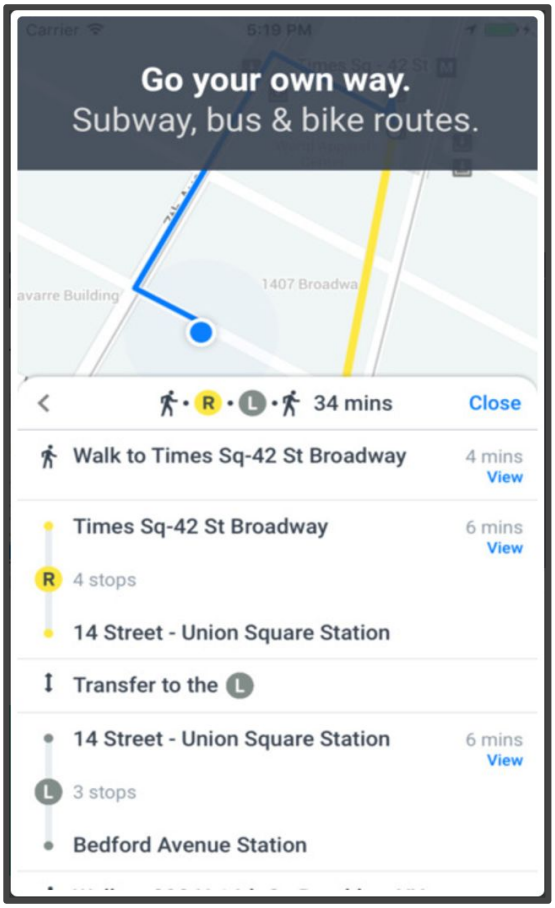


Figure 15: *Google Maps directions*

HEALTH IMPACT PATHWAYS:

Everyday is filled with an excessive number of stimuli and decisions, and the beauty of traveling a familiar, and routine commute is that it eliminates the stress of having to be mentally tuned in to every turn taken. When the L-train shuts down, people will be required to navigate alternative routes as well as new forms of transportation, and the changing environment and changing routes will make it increasingly challenging to create a new cognitive map.

Furthermore, it is both mentally and emotionally stressful to constantly update cognitive maps, particularly in overcrowded areas, and this shift can lead to confusion, stress, anxiety, etc...

Other forms of transportation that will be inundated with more pedestrians and busy commuters.

- Buses
- Sidewalks
- Biking lanes
- Number of cars

HEALTH IMPACTS:

- An HIA published by the University of Washington suggested that when proper wayfinding tools are not available, and when they are only available in English, it is easier for the population to feel lost. This can lead to a higher state of vulnerability, stress, and cause potential harm (Gundersen 2015.)

- The AARP suggests wayfinding tools are particularly necessary for the elderly. Older adults are particularly vulnerable to heightened stress and disorientation and may not have access to, or understanding of apps that promote easier wayfinding. (Hunter 2013.)

- Every neighborhood is different. Each neighborhood must be assessed according to the number of wayfinding aids they already have, and how many would be necessary to improve wayfinding skills, otherwise impacts like confusion will not be addressed properly.

VULNERABLE POPULATIONS:

- Without proper signage, older adults will be at a higher risk of emotional and mental stress (Hunter 2013).
- Children under the age of 12 have less developed navigation skills because of decreased sense of space and lower ability to integrate information (Hunter et al 2016).
- The chronically ill and disabled will be at risk, as it is more difficult for them to acclimate to new environments and paths (Hunter et al 2016).
- Foreigners may also be at a higher risk of stress. If maps and signs are too difficult to understand for people who do not speak English well, or if there is not sufficient word-graphic representation, their stress levels will increase.

RECOMMENDATIONS:

To reduce the heightened confusion, stress, anxiety and overall sense of feeling lost that the shutdown may cause, the city must provide a variety of wayfinding aids:

- Ensure the public has enhanced **technological options** to aid navigation: heightened communication with app programmers and companies like Google to suggest alternative routes other than the L.
- In the months **leading up** to the shutdown, the MTA can create a pamphlet that has a map with alternative routes highlighted and color-coded. These pamphlets can be available at any L-train stop so that people can plan out their new routes in advance, and allow themselves time to mentally acclimate to the change.
- *Below Groun*d: Signs with clearly listed alternate subway and bus routes need to be posted along the **entirety** of the L-line, including subway cars, platforms and exits.
- *Above Ground:* Signs and maps should be posted on **street corners** and at bus stations directing pedestrians to the nearest form of transportation. They can be arranged so they follow pedestrian paths from the subway to the bus/ferry/biking stations to show a commuter that he/she is headed in the correct direction.
- **Totem signs** should be set up at all Brooklyn stops

DISABILITY ACCESS

WHAT IS DISABILITY ACCESS?

Disability access addresses how well residents and commuters with physical disabilities can successfully move around a neighborhood or city. The Americans with Disabilities Act of 2010 plays a major role in ensuring this successful movement (ADA Standards for Accessible Design). Two especially important elements of this act relevant to potential impacts of the L-Train shutdown are the sections that define standards for transportation facilities and define what an accessible route is (ADA Standards for Accessible Design). Taking into consideration how the L-train shutdown will impact all persons' ability to get around New York is important as a way to ensure equal quality of life for all citizens.

CURRENT DISABILITY ACCESS AT L-TRAIN STATIONS:

- Disability accessibility on the L-Train is very limited (MTA Guide to Accessible Transit). Subway stations that are considered accessible are defined as having features compliant with the American Disabilities Act (ADA).
- Only 5 out of 24 subway stations on the L-Train line follow ADA regulations (MTA Guide to Accessible Transit, n.d.).

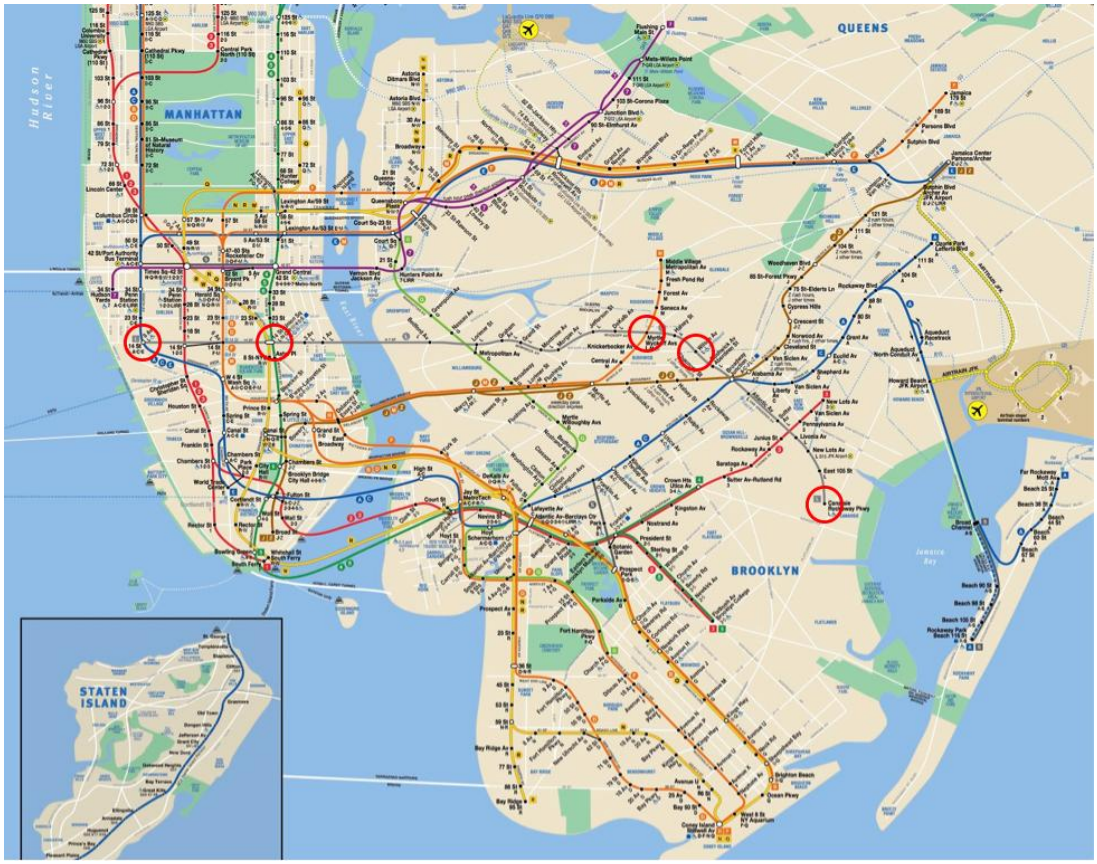


Figure 16: *L-Train accessible subway stations*

HEALTH IMPACT PATHWAYS:

- Persons with disabilities lose a means of transit as accessible L-Train stations close.
- They also must now rely on other subway lines, taxicabs, walking, and buses.
    - The nearby M, J, and Z trains have limited accessibility with 12 of 36, 6 of 30, and 4 of 20 stations being accessible respectively (MTA Guide to Accessible Transit).
    - 2% of taxicabs in NYC are wheelchair accessible (2014 Taxicab Fact Book).
    - The NYC DOT is installing ramps at all corners in NYC. Currently, 96.8% of the city's street corners have ramps (Pedestrian Ramps, n.d.).
    - All NYC buses are can accept wheelchair bound passengers (NYC Buses, n.d.).
- Persons with disabilities thus lose more accessibility in NYC due to limited accessible subway stations and taxicabs.

HEALTH IMPACTS:

- This limited accessibility as a result of fewer accessible transportation options increases commute time and complexity:
    - This makes it more difficult to access jobs, education, and leisure increasing stress levels.
    - Additionally, having limited access to necessary resources can make those with disabilities feel like they have a lost sense of control over their lives and thus lower confidence.

VULNERABLE POPULATIONS:

- Those with physical disabilities are a vulnerable population in themselves and are especially likely to face difficulty in getting around New York City with the shutdown of the L-train.
- Senior citizens are more vulnerable to falling and acquiring a physical disability because of their reduced muscle strength, flexibility, balance, coordination, proprioception, and reaction time (Kannus et al., 2005).

RECOMMENDATIONS:

To mitigate the negative health impacts of increased stress levels and a lost sense of control for those with disabilities, recommendations address issues of limited wheelchair accessibility on alternative subway lines and the limited number of accessible taxicabs.

To circumvent the inaccessible modes of transportation:

- Additionally, it was recommended at our team's workshop that for persons without smart phones, a **schedule of alternative accessible routes** for during the shutdown be posted months prior to the shutdown at transportation hubs.
- As suggested by many Brooklyn residents at our team's L-Train workshop at the Van Alen Institute, the MTA and the NYC DOT should partner with a major navigation app company such as Google Maps or MapQuest to provide a **phone application** for persons confined to a wheelchair that recommends the easiest route to use to get around during the L-train shutdown.

To improve transportation modes that lack disability access:

- As suggested by many Brooklyn residents at our team's L-Train workshop at the Van Alen Institute, there should be **MTA provided shuttles** that pick up wheelchair users and bring them to the nearest wheelchair accessible subway station.
- Have the MTA increase the number of **wheelchair accessible stops** on the nearby M, J, and Z lines (MTA Guide to Accessible Transit).
- Increase the number of wheelchair **accessible taxicabs** (2014 Taxicab Fact Book).

TRANSPORTATION HAZARDS

WHAT ARE TRANSPORTATION HAZARDS?

Transportation hazards describe the likelihood of a person getting injured or killed while utilizing various modes of transportation in New York City. The scope of this topic includes transportation hazards for subway, roadways, and walkways.

CURRENT TRANSPORTATION HAZARDS:

- According to the MTA, about 300,000 people use the L-train daily (Everything about the L Train, 2016). This large number is the result of the limited number of cross town trains that serve New York City and increases the risks of injury or death due to overcrowding incidents.
- A 2011 study notes a new high in the number of people hit by moving subway trains. The number had increased to 147 in just a one year span (Mounier, 2012).
- Over one-third of all fatalities from falling on to tracks are the result of accidentally falling on them (Sullivan & Galleshaw, LLP, 2016).
- Bike-car collisions alone cause on average 2.6 deaths per million New Yorkers every year (Bicyclist Fatalities, n.d.).
- Pedestrian-car collisions cause on average 34.9 deaths per million New Yorkers every year (NYC DOT, 2010).

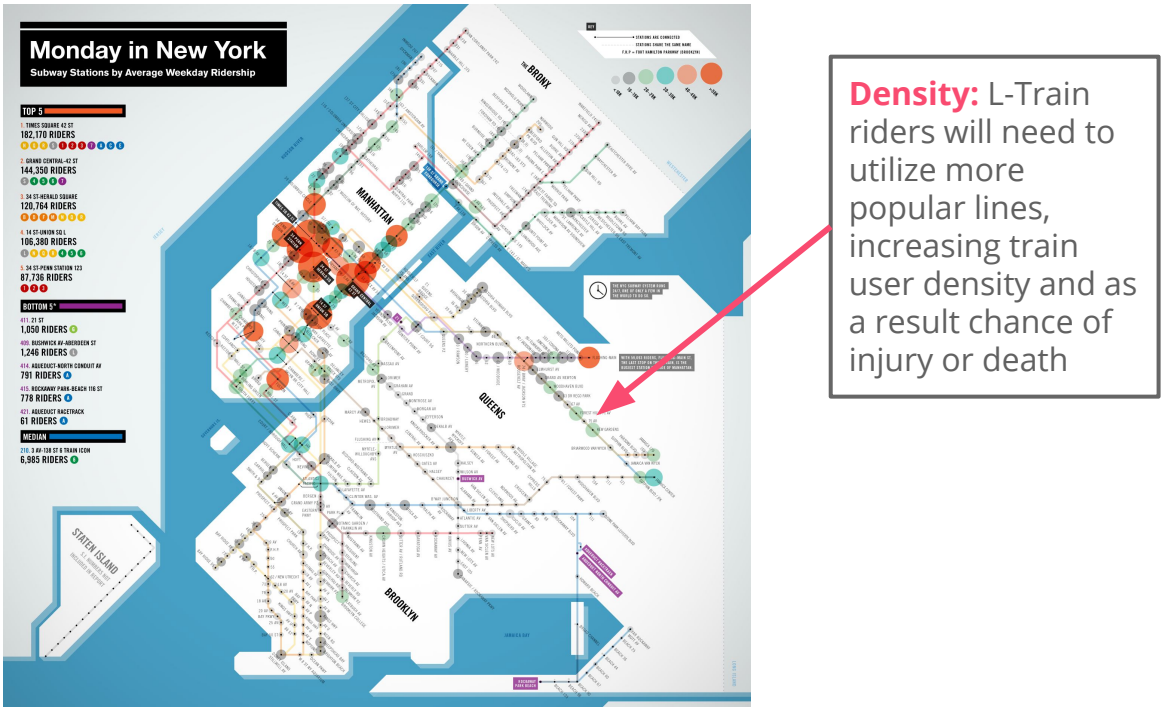


Figure 17: *Subway Usage Frequency on an Average Monday*

HEALTH IMPACT PATHWAYS:

- Increased usage of other means of transportation including other subway lines, taxicabs, sidewalks, and buses.
- Increased volume of transportation users on select subway lines, sidewalks, buses, and roadways.

HEALTH IMPACTS:

- High density is likely to increase adverse health effects for travelers (Evans & Wener, 2007). Crowding decreases the amount of space between passengers on different modes of transportation, causing an increase in the stress and anxiety levels of those travelers (Evans & Wener, 2007).
- With more people in subway stations, subway cars, sidewalks, and roadways, the likelihood for an accident or collision increase due to the sheer increase in density of people in these spaces. This increase in risk of collision will contribute to travellers feeling that they have lost some of their control over their environment.

VULNERABLE POPULATIONS:

- With overcrowding on various means of transportation, risk of physical injury is increased for all.
- Those with mental and physical disabilities have a larger risk of incident and injury, as they are not able to respond as quickly to potentially dangerous situations.

RECOMMENDATIONS:

In order to mitigate the negative health impacts of increased stress and anxiety levels as well as the loss of a sense of control over one's environment, recommendations will be focused on preparing all transit users for a change in travel patterns and minimizing crowding on these new alternative routes.

In order to prepare transit users for changes in travel patterns:

- As suggested by Brooklyn residents at our team's L-Train workshop, the MTA and NYC DOT should **communicate** with New York residents early via signs and in-station announcements about how the shutdown will affect them and how to safely navigate these new methods of travel.
- Have **safety training sessions** for all transit operators that instructs them on how to safely manage the new larger volumes of passengers.

In order to minimize crowding on alternative routes:

- Have the MTA and NYC DOT create a free app for travelers that suggests the **least congested commute route** that avoids the temporarily out-of-service section of the L-Train (Evans & Wener, 2007).
- Encourage companies to implement **staggered work times** so employees can come to work and go home either a few hours early or a few hours late. This will reduce the number of people utilizing alternate transit at the same time.

HEALTH-RELATED BEHAVIORS

Health-related behaviors are one category of health determinants. Health-related behaviors refer to activities that may detect or prevent disease and improve health and well-being (Conner, 2002). In terms of the L-Train shutdown, there are a few health-related behaviors that could be affected: **physical activity, diet,** and **sleep.**

PHYSICAL ACTIVITY

WHY PHYSICAL ACTIVITY?

Physical activity refers to those actions affecting exercise and physical movement and has been linked to positive health outcomes (Braveman et al., 2011). Research has shown that adequate physical activity can lower obesity, lower blood pressure, increase metabolism, and improve cardiovascular health, while inactivity can contribute to poorer health all around (Bogg and Roberts, 2004). Psychological benefits also exist, from improved happiness to less chronic stress (Bogg and Roberts, 2004).

IAs the L-train shutdown is proposed to increase commute times for riders, alternative modes of transportation will have to be considered. Walking and biking are two possibilities, which could improve the health of able populations. For those disabled and elderly, however, the physical activity could prove detrimental.

CURRENT CONDITIONS

The baseline health of Brooklyn can be assessed through physical activity, obesity, and diabetes data. This data comes from periods where the L-train was in operation, so data reflects the conditions of populations with access to this train. In 2008, Williamsburg and Bushwick both reported **lower levels of physical activity** than the rest of Brooklyn. In a survey asking about exercise patterns, only 66.2% of adults in these two neighborhoods had exercised in the past 30 days. Brownsville has a slightly higher rate of physical activity, at 72.9%. This is **lower than the overall average of 69.6% for Brooklyn** (Brooklyn Community Foundation, 2016).

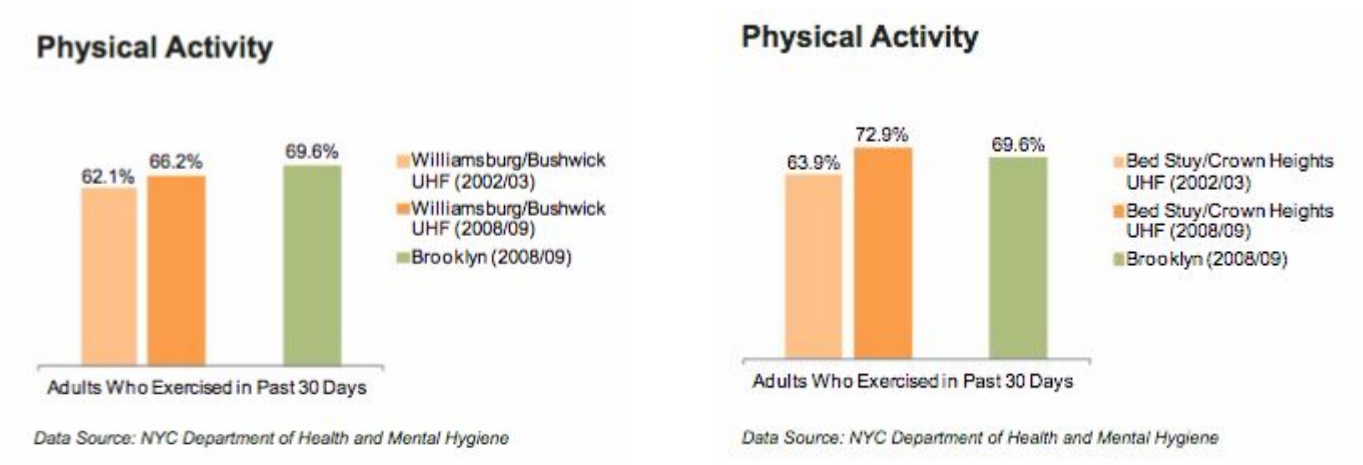
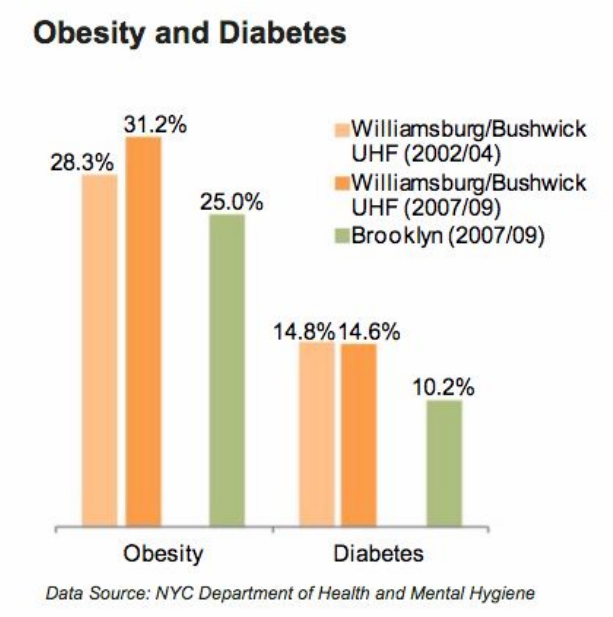


FIgure 18 and 19 : Physical Activity in Bushwick and Williamsburg (left) and Brownsville (Crown Heights area, right)

CURRENT CONDITIONS

In terms of obesity, Williamsburg, Bushwick, and Brownsville have a **higher prevalences of obese individuals than Brooklyn as a whole.** In 2008, 31.2% of individuals were obese in Williamsburg and Bushwick neighborhoods, which is higher than the 25.0% in all of Brooklyn. Brownsville had a rate of 29.1%. These neighborhoods also have **higher rates of diabetes**. For the same 2008 year, WIlliamsburg and Bushwick reported a 14.6% rate of diabetes. Brownsville reported 11.6%. All three were higher than the 10.2% rate of diabetes in all of Brooklyn (Brooklyn Community Foundation, 2016).



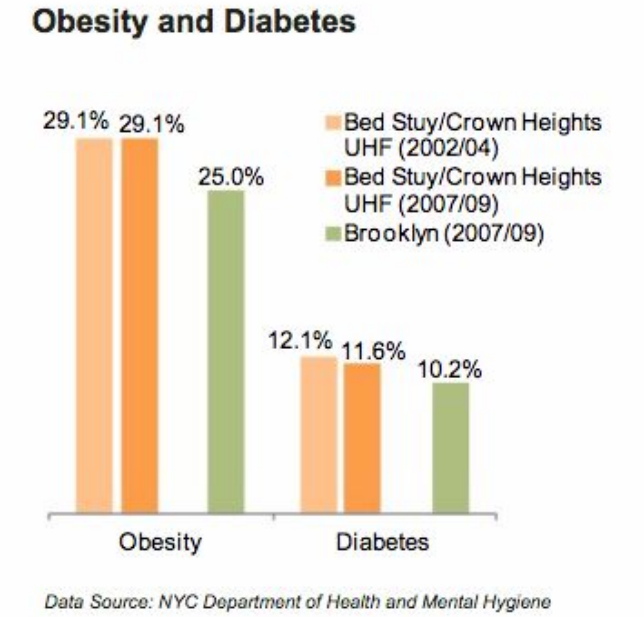
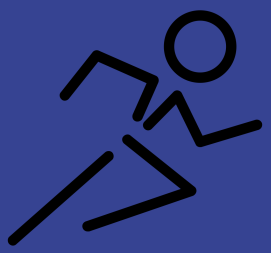


FIgure 20 and 21: Obesity and Diabetes in Bushwick & Williamsburg (left) and Brownsville (Crown Heights area, right)

HEALTH IMPACT PATHWAYS:

The L-train shutdown is expected to **increase commute times** and force riders to find alternative modes of transportation. As a result, many individuals will rely on more active modes of transportation, such as walking and biking. This will **increase the level of physical activity** and exercise for able populations, which in turn can **improve physical and mental health.**

Alternatively, the L-train has **potential negative consequences** on physical activity. For those disabled and elderly populations, the change in physical activity may be a **hindrance to movement and freedom**, as these individuals will face difficulties with physical movement. This could **worsen physical and mental health**.



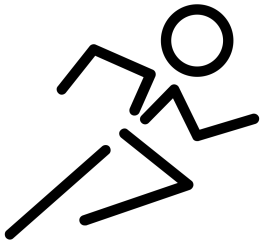
HEALTH IMPACTS:

PHYSICAL ACTIVITY AND CHRONIC DISEASE

Commuting by bike or walking significantly reduced cholesterol levels, BMI and hypertension among adults (Sallis et al., 2004). This promotes healthier lifestyles in adults and can **reduce the risk of chronic disease**. In terms of the L-train shutdown, individuals will be forced to rely on alternative modes of transportations. The neighborhoods examined in this report are all highly walkable and somewhat bikeable (Walk Score, 2017). This means that individuals have the option to walk or bike to their destinations. This has the potential to increase physical activity, as a result, which has **beneficial effects on physical and physiological health**.

PHYSICAL ACTIVITY AND MENTAL HEALTH

Research has shown that physical activity also has moderate effects on mental health. Physical activity can help **soothe depression, anxiety, self-esteem, and cognitive functioning** (Biddle and Assare, 2011). Thus, the L-train shutdown has the potential to **improve mental healt**h for those individuals engaging in more physical movement.



VULNERABLE POPULATIONS

For the following groups of vulnerable populations, physical activity will pose more difficulties than benefits in the wake of the L-train shutdown, as commuting will become much harder for them.

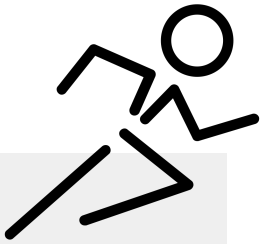
- **Low-income populations**
  - They have less monetary means by which to afford alternative modes of transportation.
  - In order to cut costs, they may choose to walk or bike for extended periods of time to work, which could have detrimental effects to their physical health. While it does increase physical activity, it could add to their fatigue..

- **Less mobile people (disabled, elderly, children, etc.)**
  - They have less physical ability to move around and engage in walking or biking.
  - The increased physical activity may worsen physical and mental health as these populations would have to engage in movement that is difficult for them. They may not be able to get to their destinations like they could before, which could harm their mental well-being, as the stress and feelings of incapability could increase.

RECOMMENDATIONS

In order to mitigate the negative consequences of the L-train shutdown, we offer recommendations that delineate clear alternative modes of transportation that can help those physically disabled, elderly, and children populations. However, the L-train shutdown does pose some positive benefits to physical activity, so recommendations have been suggested in order to enhance those effects.

- **Establish shuttle lines that operate above ground parallel to the L-train for those less mobile populations.**
  - These shuttles would run adjacent to the L-train, giving these populations the a way to access destinations they previously used the L-train for. This would decrease the need for physical activity and maintain their health.



RECOMMENDATIONS

- **Delineate clear pedestrian and bike pathways across Brooklyn adjacent to the L-train to offer those able individuals safe and reliable modes of transport.**
    - The MTA should mark the roads that walkers and bikers can use in order to offer safe modes of travel. Additionally, this will encourage people to use these modes of transport as they will have their paths clearly laid out for them. This can increase physical activity and in turn improve health.

- **Improve Access-A-Ride to offer direct transportation from home to end destination in order to eliminate excess movement for physically disabled and elderly.**
    - At the stakeholder meeting in NYC, representatives spoke of the difficulties associated with using Access-A-Ride. We recommend a revision of this program that makes it easier for passengers to book rides and gain clearance to use this system. This will significantly improve the mobility of those less able populations.

- **Plant more natural elements along streets and current bike/foot paths to incentivize individuals to walk/bike instead of drive.**
    - The MTA should work with the city to introduce more natural elements into the neighborhoods affected by the L-train shutdown. Factors such as trees, plants, and more engaging visual objects could increase the incentive for individuals to want to bike and walk as they would have something to look forward to when outside. This could reduce the number of car drivers and increase physical activity, further improving health overall.

- **Offer daily challenges or physical activity goals to convince L-train riders walking and biking is enjoyable and necessary.**
    - The MTA should increase engagement with the L-train riders by educating them on the benefits of physical activity via billboards and posters in the subway. Once the L-train is shut down, the MTA could release daily fitness goals or challenges that encourage riders to move around. This could make riders less irate with the shut down as they engage in these activities to improve health. There are many fitness tracker apps already available, so the MTA could partner with an existing one to create some sort of “NYC Fitness Challenge” for the duration of the L-train shutdown. Through the course of this project then, the MTA would help improve the health of its riders.

DIET

WHY DIET?

Diet refers to the nutrition and food choices an individual makes. Research links a well-balanced diet containing the essential nutrients to long-term health (Martin et al., 2013). It is an important moderator for obesity and influences morbidity and mortality. Diet is a significant contributor to cholesterol, heart function, and development of diabetes (Braveman et al., 2011).

The review of extant literature suggests the importance of diet in humans' health. While diet may not have direct correlation with the L-Train shutdown, as the baseline data that follows suggests, the current diet conditions in the U.S. at large as well as the affected low-income neighborhoods in Brooklyn suggest that there is room for diet to be considered in the future recommendations to moderate the negative health impacts that L-Train will cause.

In terms of diet, stakeholders from the surrounding communities in Brooklyn affected by the L-train spoke of the effects of the shutdown on access to grocery stores. For those with low socioeconomic status, the train is an excellent mode of transportation to healthy food sources and supermarkets in other neighborhoods. Many residents spoke of buying groceries in a different area from their place of residence, as the options were much higher elsewhere. Without this access, many may be forced to purchase more expensive options or resort to unhealthier options that are cheaper and available in their immediate surroundings.

CURRENT CONDITIONS:

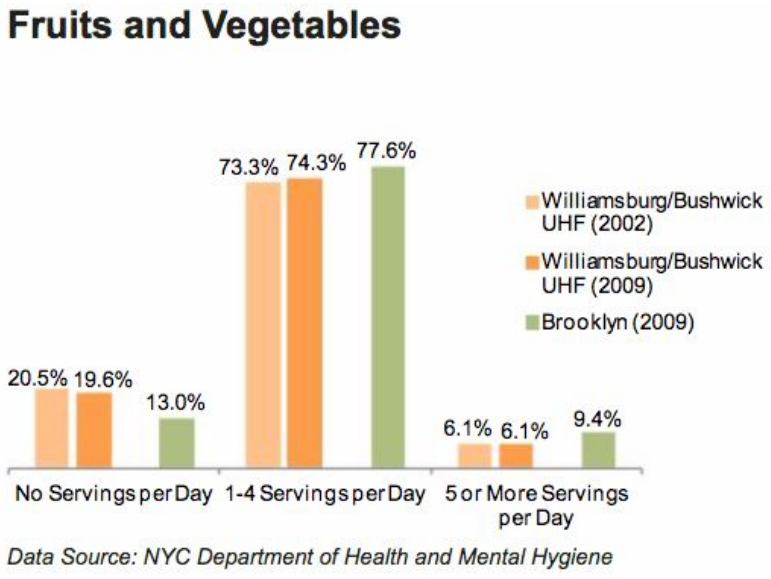
FRUITS AND VEGETABLES CONSUMPTION

Fruits and vegetables were consistently the most frequently occurring definition of healthful eating regardless of income, race, or sex (Eikenberry & Smith, 2004). According to the USDA, fruits and vegetables are major contributors of important under-consumed nutrients, may reduce the risk of many chronic diseases, and may help individuals achieve and maintain a healthy weight when consumed instead of higher calorie foods.

Americans eat less than the recommended amounts of vegetables and fruits. The analysis of the percentage of the U.S. population ages 1 year and older with intakes below the recommendation or above the limit for different food groups and dietary components reveal that vegetables and fruit intakes are significantly below the goal (USDA, 2015).

CURRENT CONDITIONS:

Nationally, people are not consuming the recommended amount of fruits and vegetables (USDA, 2015). The same is evident in the key affected Brooklyn neighborhoods of Williamsburg, Bushwick, and Brownsville as reported in the Brooklyn Neighborhood Reports published in 2012. USDA (2015) recommends to consume 5+ servings of fruits and vegetable each day for healthy diet. As portrayed in **Figure 22**, the households in Williamsburg and Bushwick, revealed that the majority (74.3%) consume only 1-4 servings of fruit and vegetables, and only 6.1% meet the USDA guidelines of consuming 5 or more servings. This pattern was consistent particularly in the low-income neighborhoods on focus although the entire Brooklyn showed similar patterns. Perhaps in alignment with the lacking fruit and vegetable intake, the rate of obesity and diabetes were higher in these low-income neighborhoods in Brooklyn, As **Figure 23** portrays, obesity and diabetes rates were much higher in Williamsburg and Bushwick than the average for entire Brooklyn. The pattern was consistent with other low-income neighborhoods in Brooklyn.



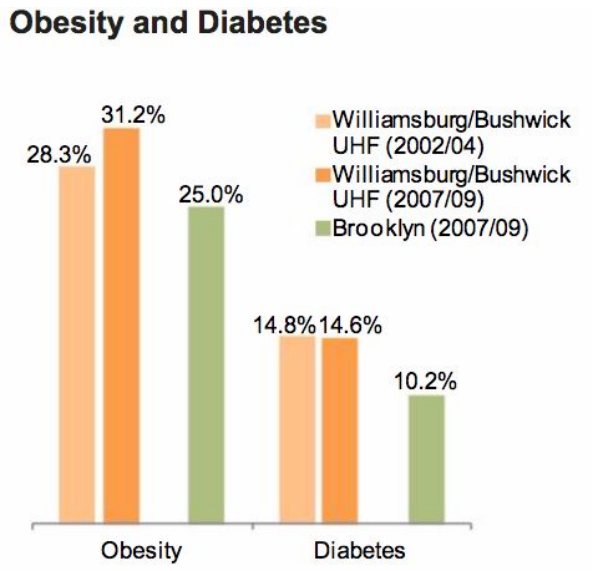
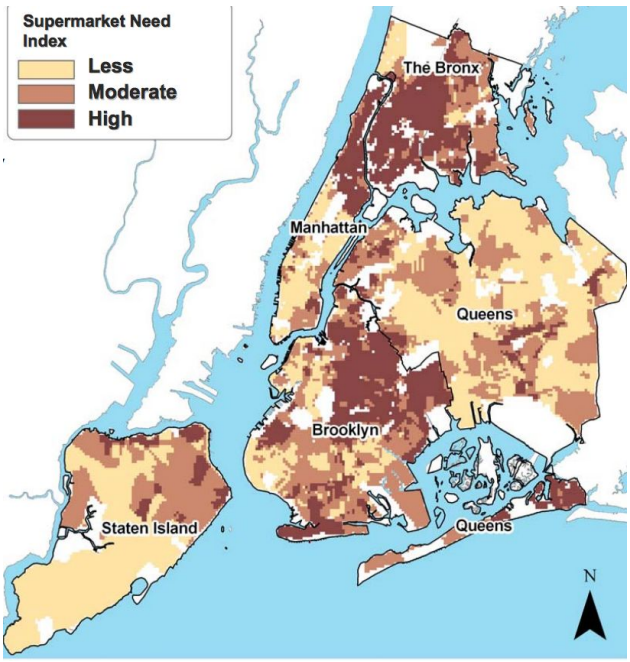


Figure 22 (left). **Figure 23** (right). Brooklyn Neighborhood Report on Current Conditions in Williamsburg/Bushwick (2012).

FOOD DESERTS

The emergence of urban “food deserts”, areas that are more than a mile away from a reliable food source has become rampant, especially within city centers where low-income people have poor access to vegetables, fruits, and other whole food. According to the U.S. Department of Agriculture (USDA)’s food desert study (Ver Ploeg et al., 2009), approximately 23.5 million people, including 6.5 million children, live in food deserts and cannot access a supermarket within one mile of their homes. In 2008, an estimated 49.1 million people, including 16.7 million children, experienced food insecurity (limited availability to safe and nutritionally adequate foods) multiple times throughout the year.

According to the study, low-income areas have only 75% as many chain supermarkets compared to middle-income areas, and those who live in low-income areas that are more than a mile from a supermarket spend more time (19.5minutes) traveling to grocery stores than the national average (15 minutes). This national “food desert” phenomenon in low-income neighborhoods was consistent in the affected Brooklyn neighborhoods, as portrayed by the high need for supermarkets shown in **Figure 24**. and low share of fresh food retailers in the area shown in **Figure 25**. The need for supermarkets in the affected Brooklyn neighborhoods is high as indicated with dark brown colors on the map, and the share of fresh food retailers are below average in those areas. The lack of supermarkets and fresh food sources can negatively impact the health status of the residents in food deserts, as they are more inclined to make unhealthy food and nutrition choices.



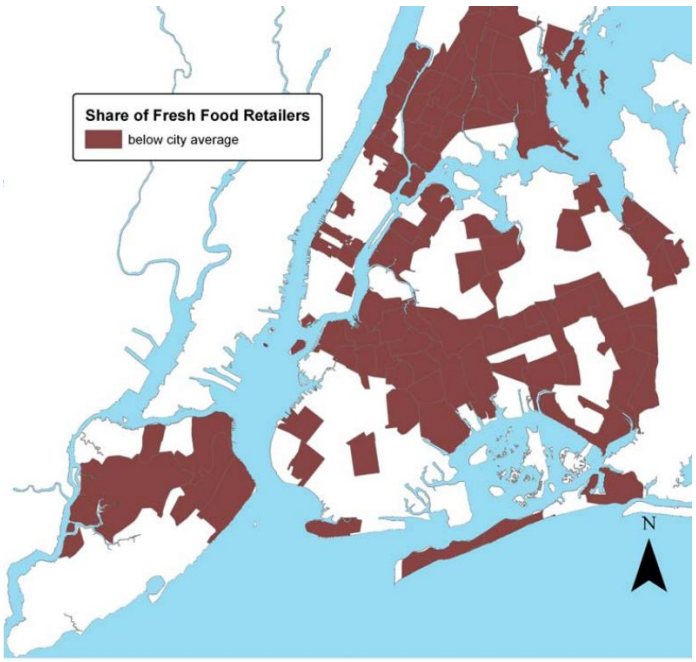


Figure 24 (left). **Figure 25** (right). Supermarket Need Index and Fresh Food Retailers Distribution in New York City (Source: NYC Department of City Planning).

HEALTH IMPACT PATHWAYS:

The baseline conditions show that the affected populations in Brooklyn neighborhoods are not consuming the optimum amount of fruits and vegetables, which serve as an indication for healthy diet and nutrition status. This has negative health implications as poor diet is linked with obesity, diabetes, and mortality.

The L-train shutdown is expected to lead to **increased commute times** and **decreased amount of time available to spend on other activities, including grocery shopping and cooking healthy meal**. Moreover, when L-train shutdown leads to **increased monetary spending on alternative transportation systems, disposable spending available for healthy food will decrease**. It is likely that people could opt for unhealthy food, such as fast food and sugary snacks, that are quicker, cheaper, and easier to access. Ultimately, this will lead to **worsened diet and nutrition intake**, which would **negatively affect health**.

Alternatively, diet can also be positively affected by the L-train shutdown. With the shutdown, it is likely that **walking time and physical activity would increase**, which would lead to **increased healthier food choices**, resulting in **health benefits**.

HEALTH IMPACTS:

DIET AND DIABETES

When people opt for fast food and sugary snacks due to lack of time and limited disposable spending resulting from the L-Train shutdown, they can suffer from diabetes. Higher intake in refined sugars, refined fats, oils and meats, are shown to increase the incidence of type II diabetes and coronary heart disease, while alternative diets are shown to reduce incidence diabetes by 16%–41%, cancer by 7%–13% and mortality rates from coronary heart disease by 20%–26% (Tilman & Clark, 2014).

DIET AND OBESITY

Unhealthy food choices are likely to lead to higher chances of obesity. The percent of snacking for energy from desserts, sweets and sugar-sweetened beverages were associated with negative diet quality and higher body mass index (BMI), while those from fruit and juice were associated with positive diet quality and lower BMI (Barnes et al, 2015).

DIET AND PHYSICAL ACTIVITY

When people are more physically active, they are more likely to adopt healthier diet patterns. Sedentary individuals tend to consume smaller amounts of healthful foods than active participants, and harmful nutrients like saturated fat, trans fat and dietary cholesterol were inversely associated to physical activity of the participants (Gillman, et al, 2011).

VULNERABLE POPULATIONS

For the following groups of vulnerable populations, the negative impacts from the worsened diet and nutrition intake will have more severe repercussions with the lack of resources and physical abilities to cope with the impacts of the L-Train shutdown.

- **Low-income populations**
  - They have less financial resources to spend on healthy foods.
  - They are more likely to live in food deserts, areas that lack access to vegetables, fruits, and whole foods, and they have less financial resources to spend on traveling to sources of healthy foods.

- **Less mobile people (disabled, elderly, children, etc.)**
  - They have less physical capability to access healthy foods and have to input more physical effort in order to travel to food sources.
  - They have less physical capability to carry groceries from food sources to their homes.

RECOMMENDATIONS

In order to lessen the negative health impact that result from the L-Train, specifically relating to healthy diet and nutrition status of the affected populations, we recommend to consider creating increased access to healthy food sources. This can be achieved either by bringing the healthy foods to people or by bringing people to healthy foods.

- **Create increased access to healthy foods in affected neighborhoods and on the pathway of commuting. (Bring Healthy Food to People)**
  - Establish more local food markets or mobile food carts.
  - Provide affordable healthy meals near transportation systems, e.g. train stations and bus stops, via social programs like “Meals on Wheels”.
  - Partner with local food subscription or delivery enterprises to bring healthy food to people’s homes.

- **Provide extra assistance by providing an intermediary transit between home and alternative modes of public transit to food sources, e.g. supermarkets. (Bring People to Healthy Food)**
  - Have regular shuttle buses, dollar vans, or rideshares available between people’s homes and food sources.

SLEEP

WHY SLEEP?

Sleep is an additional health-related behavior that affects overall health, as studies have linked rest to both chronic disease and mortality (Laposky et al., 2016). Sleep patterns have been found to affect psychological state of mind, as sleep can affect mental alertness and awareness. Research has shown that physical activity, diet, and sleep are quite influential on the development of both physical and mental health, thus it is important to examine them in the context of the L-train shutdown. In the event of the shutdown, it is expected that there will be unprecedented **commuter stress**, which can significantly impact one's **sleep quality**, and ultimately health and well-being.

CURRENT CONDITIONS:

The following data come from national-level data from annual polls conducted by the National Sleep Foundation. Although these data do not present a scenario that is representative of sleep patterns in New York City, they give a fair idea of how various subgroups in the US exhibit patterns of sleep that may be linked to corresponding health outcomes.

Sleep quality and health

Compared to adults who reported poorer health, adults of **higher health status**:

- Got **more sleep** (on average 30 minutes in the past week) (Figure 23.)
- Were twice as likely to report **better sleep quality** (63% vs. 31%) (Figure 24.) (National Sleep Foundation, 2015)

Sleep Quality and stress

Compared to adults who experienced moderate stress (31%), 1 in 10 respondents (12%), who complained of **severe stress**:

- incurred **greater sleep debt**, e.g. getting less sleep than they felt they needed (49 minutes vs 2 minutes)
- Were twice as likely to report **poorer sleep quality** (83% vs. 35%) (National Sleep Foundation, 2015)

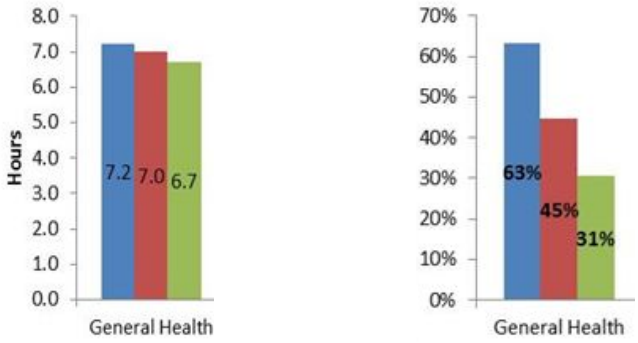


Figure 26: *(left) Sleep Duration and General Health;* **27** *(right) Sleep Quality and General Health (National Sleep Foundation, 2015)*

CURRENT CONDITIONS:

Sleep Duration in Children and Adolescents

- Compared to younger children (6-11 years), **older children** (15-17 years) have much **shorter sleep duration on school nights**, with over half of them (56%) getting 7 hours or less per night (Figure 25.) (National Sleep Foundation, 2014)

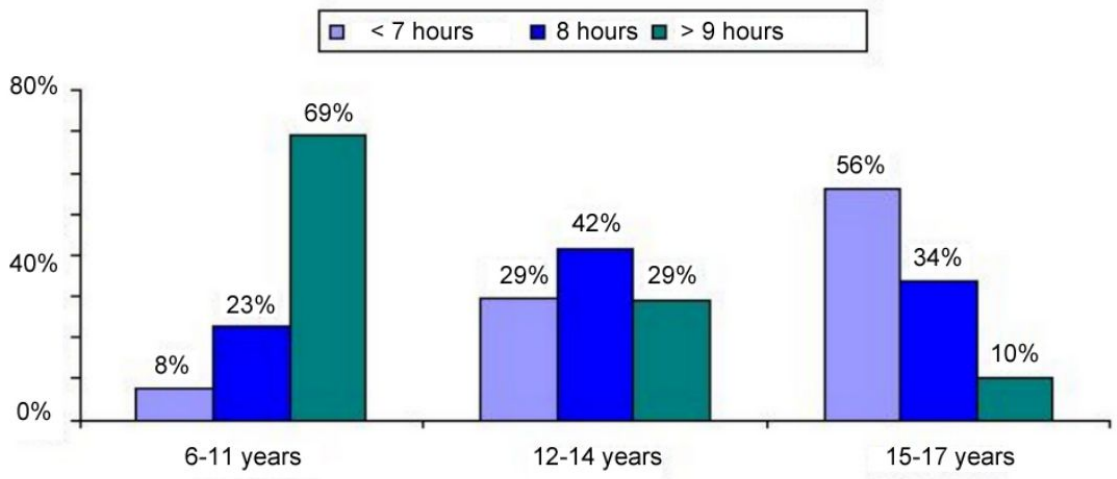


Figure 28: *Sleep Duration and age group (National Sleep Foundation, 2014)*

Sleep and Exercise

Compared to adults who do not engage in physical activity (9%), those **who do light to vigorous physical activity** (91%):

- reported that their **sleep needs were met** (70% - 68% (depending on degree of activity) vs. 53%)
- reported **higher sleep quality** (83% - 76% (depending on degree of activity) vs. 56%) (National Sleep Foundation, 2013)

Sleep and Diet

Compared to adults who reported sleeping 8 or more hours (28%), those who **slept for less than 6 hours** on a weekday (20%):

- reported that they were **unable to eat healthy** (23% vs.7%) (National Sleep Foundation, 2009)

Sleep Problems and Work

Out of all the **working adults** who took the the survey , 65% experienced **sleep problems** at least a few nights a week in the past month, while 44% of working adults reported sleep problems occurring almost every night (National Sleep Foundation, 2008).

HEALTH IMPACT PATHWAYS:

The baseline conditions show that people in the US who report **lower sleep duration** and **sleep quality**, also report **poorer health status**, and **poorer health related behavior** (National Sleep Foundation, 2015; National Sleep Foundation, 2009). The L-train shutdown is expected to lead to **increased commute times** and **commuter stress**. This in turn may lead to **lesser time available for quality sleep**, which in turn could **negatively affect health**.

HEALTH IMPACTS:

Sleep restriction and **unhealthy sleep** practices brought about by the shutdown of the L-train may have potential **short and long term effects on health** and well-being of adolescents (Owens, 2014). Unhealthy sleep practices have significant negative health impacts such as chronic sleep loss, depression, increased risk of obesity and high rates of drowsy driving accidents (Owens, 2014). Self-rated health is significantly associated with short sleep duration (Steptoe et al, 2006). **Short sleep duration** in the event of the L-train shutdown could pose a **greater risk of obesity** in children and adults (Cappuccio et al, 2008).

VULNERABLE POPULATIONS

- **Adolescents** in the US have reported **lower sleep duration** on school nights than younger children (National Sleep Foundation, 2014). The L-train shutdown is expected to further reduce sleep duration and quality among adolescents on school nights due to **increase in commute time**, and consequently lead to **poor health**.

- **Working adults** in the US reported suffering from periodic **sleep problems** (National Sleep Foundation, 2008). The L-train shutdown may exacerbate **work-related stress** due to **longer commutes**, and multiple-changeovers resulting in greater uncertainty and higher **commute stress**. This in turn could potentially worsen sleep problems experienced by working adults and consequently **negatively impact their health**.

RECOMMENDATIONS

Office workers' **exposure to daylight** has a positive effect on their nighttime **sleep quality** (Hubalek et al, 2010). It also significantly **reduces the impact of sleep loss** on sleepiness levels and workplace performance (Phipps-Nelson et al, 2003). **Access to nature** has healthful impacts on **duration of sleep** which results in **positive mental health** and **active lifestyle** (Astell-Burt et al, 2013).

- We recommend that the MTA promote to their commuters the benefits of **exposure to daylight, nature and practice of active lifestyle**; and how they affect one's sleep quality and health. This through educational material posted along the subway platform, through pre-recorded **announcements** in the train, as well as **health messages and alerts** on the "New York Subway - MTA map and route planner" mobile app.

- **Routes** suggested by the MTA mobile app to get to the subway station from where one is, may also be manipulated to expose the user to nature and daylight, eg. proposing routes that pass through a local park

EMPLOYMENT AND LIVELIHOOD

Employment and livelihood is another health determinant category that can affect overall well-being. Employment refers to a job or set of jobs providing a flow of income which can be used to sustain livelihood, a set of activities and strategies used by individuals to maintain a living (PDNA Guidelines, 2016). Successful employment and livelihood rely on a few factors. **Job accessibility**, as well as job security, can affect the types of jobs individuals hold which in turn affects sources of income. **Occupational stress** can significantly impact workplace productivity and performance. This has mediating impacts on health, as it can all affect the economic, physical, and social assets people have on hand to promote healthy living and access resources.

ACCESSIBILITY TO JOBS

WHAT IS JOB ACCESSIBILITY?

Accessibility to jobs refers to the ease by which an individual can commute to work and reach his/her destination. Job security refers to the assurance individuals have that their careers are guaranteed and not at risk (Levine, 1998). Research has shown that individuals tend to pick housing that guarantees an easy commute to work and search modes of transportation prior to settling down (Levine, 1998). Increased difficulty to commuting via the L-train shutdown could increase mental stress. Further, job security allows individuals to maintain positive mental health (Levine, 1998). Having a secure job is necessary to promote a healthy lifestyle and secure way of life.

CURRENT CONDITIONS

Bushwick, Brownsville, and Williamsburg are fairly low-income neighborhoods. As a result, the median incomes are low and most residents hold blue-collar jobs. In 2008, in Bushwick, 60.7% of residents had jobs. In Brownsville, this number is 56.3%. In Williamsburg, 63.1% of residents had jobs. Bushwick and Brownsville are lower than the Brooklyn average of 61.1%. Bushwick and Brownsville also have higher rates of unemployment than Brooklyn as a whole. Bushwick has an unemployment rate of 8.3%, while Brownsville is higher at 12.9%. Williamsburg has an unemployment rate of 5.2%. These rates are higher than Brooklyn's 8.0% unemployment rate. The median income in Bushwick is $34,236 and $26,335 in Brownsville. The median income in Williamsburg is $42,693. All three are lower than the $43,755 for Brooklyn as a whole (Brooklyn Community Foundation, 2016).

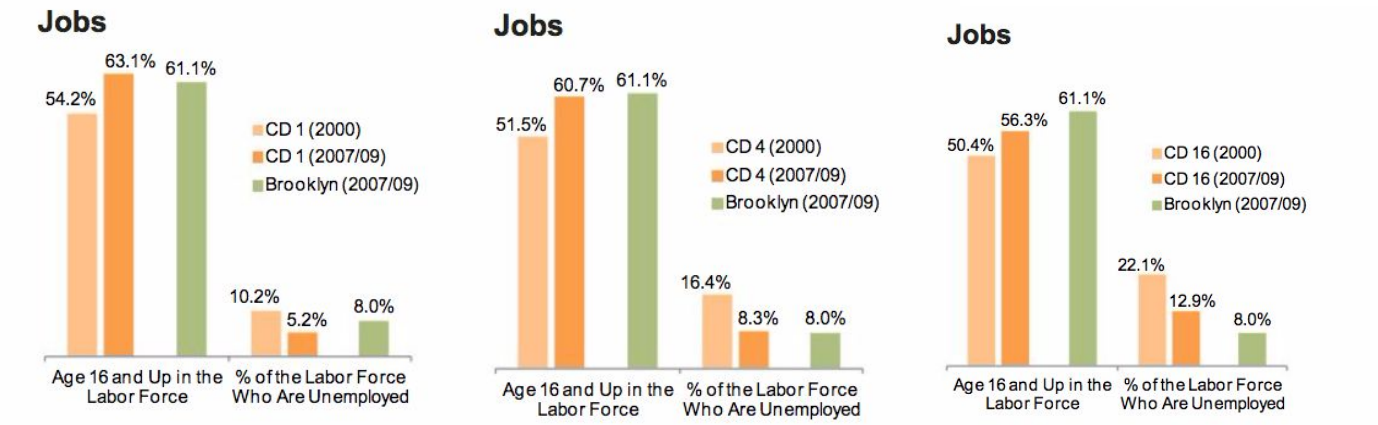


Figure 29: *Rate of Labor Force Participation in (left to right): Williamsburg (CD1), Bushwick (CD4), Brownsville (CD16). CD refers to the "Community District," which is the community number assigned to each neighborhood.*

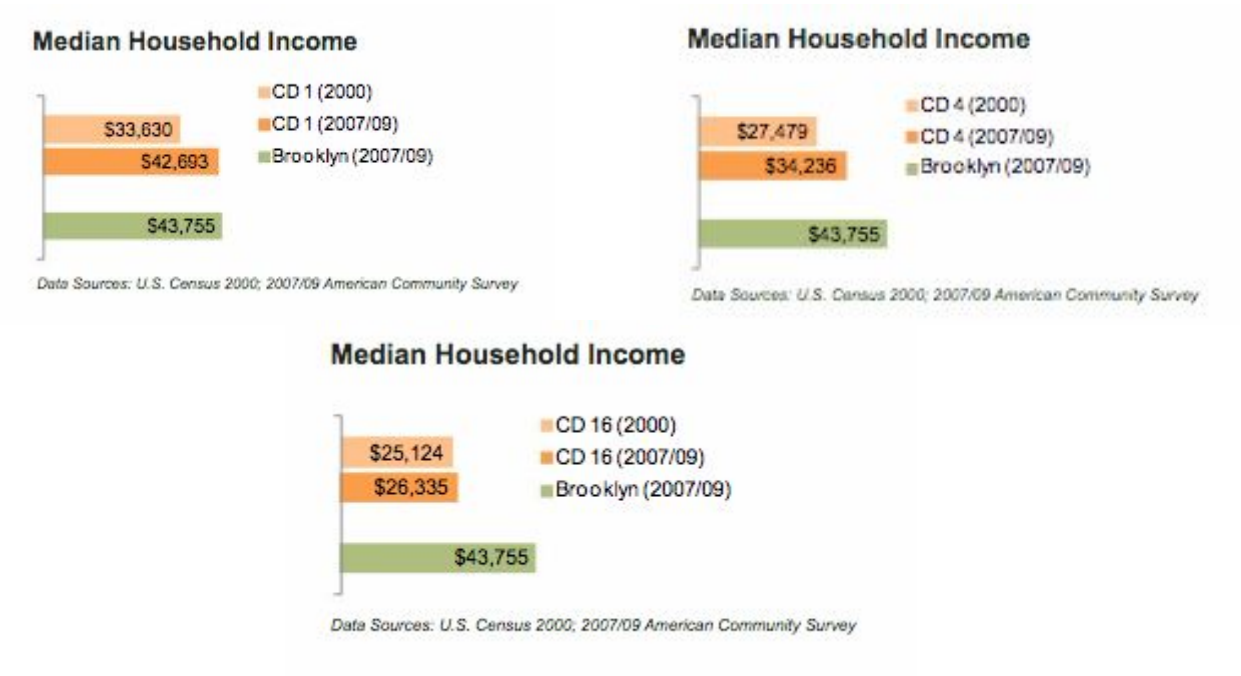
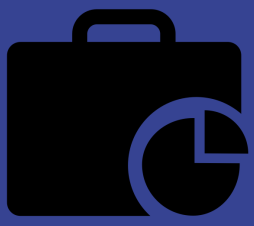


Figure 30: *Median Incomes in Williamsburg (top left, CD1), Bushwick (top right, CD4, Brownsville (bottom, CD16). CD refers to the "Community District," which is the community number assigned to each neighborhood.*

The jobs that residents of these three neighborhoods hold are largely blue-collar. The top five jobs in Williamsburg and Bushwick from 2007-2009 were nurse/health home aide, janitor, retail salesperson, cook, and construction laborer. In Brownsville, the top five jobs were nurse/health home aide, security guard, janitor, child care worker, and office clerk. These jobs are all fairly low-income and require travel to other areas outside of their neighborhood. For comparison, the top five jobs in all of Brooklyn for this same time period were nurse/health home aide, administrative assistant, elementary/middle school teacher, janitor, and retail salesperson. While some of the jobs are the same, there are a few in the rest of Brooklyn that require less travel and offer higher pay (Brooklyn Community Foundation, 2016).

HEALTH IMPACT PATHWAYS:

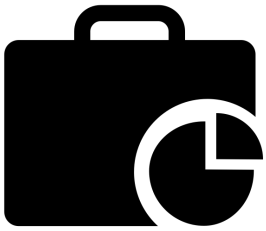
The L-train shutdown is expected to have **significant negative impacts on job accessibility**, as the train is a key mode of transit for many individuals. The L-train shutdown will force riders to find alternative modes of transportation that may not be as efficient or cost-effective. This could **worsen mental health** as the stress of getting to work increases and could in turn have effects on chronic disease and cardiovascular health.



HEALTH IMPACTS:

JOB ACCESSIBILITY AND MENTAL HEALTH

At the stakeholder meeting in NYC, many small business owners and individuals spoke of the necessity of the L-train in their daily commute. Without this train, their **jobs could be at risk.** This would create j**ob instability**, which refers to jobs with uncertain employment status or low-wage jobs that offer few benefits (Lewchuk et al., 2003). Unemployed individuals and people with uncertain job statuses have **greater issues with mental health and less access to healthcare services**. This can affect physical and physiological health. In terms of the L-train shutdown, employees using the train will have increased commute times. This could **increase stress** if they have to leave for work earlier or can no longer access their jobs. This could **harm mental health.**



VULNERABLE POPULATIONS

The L-train shutdown could affect job accessibility. **Low-income workers relying on the train as an affordable mode of travel would be negatively impacted**. If their jobs are put at risk, they could lose income, which could negatively affect their livelihood. They may also have to use more expensive transit or find other jobs, which could create stress. This could could **harm mental health**. It could also affect physical health because they **may lose access to healthcare services and benefits**. They may not be able to afford getting care without a job.

Disabled and elderly populations also rely on the L-train as an easily accessible way to commute. For these individuals, the L-train shutdown could **threaten their livelihood.** With no other viable form of transportation available, many disabled and elderly individuals could lose their jobs or be forced to quit. This would mean a loss in income and a **probable decrease in mental health status**.

RECOMMENDATIONS

To reduce the negative mental health impacts of limited accessibility to jobs, the following should be considered:

- **The MTA should offer shuttle service along the L-train to give low-income workers and disabled/elderly populations a reliable way to work.**
    - This bus service would mitigate the stress created from having to find alternative modes of transit. This could prevent an increase in commute time and make it easier for low-income workers and disabled/elderly individuals to get to work. This would also be a more affordable option than having to buy a car or take a taxi.
- **Employment sites relying on the L-train could introduce flexible working hours or the option to work from home.**
    - Flexible work hours and the option to work from home would give employees more control over their commute. This could improve mental health because it would decrease the stress associated with finding alternative modes of transit. This could have downstream effects on employee happiness and productivity.

OCCUPATIONAL STRESS

WHAT IS OCCUPATIONAL STRESS?

Occupational stress may be brought about by increased workload, working overtime, shift-work etc. and can have serious implications on workplace efficiency and can affect workplace productivity (Public Employees Federation, 2006). In the context of the L-train shutdown, occupational stress maybe exacerbated for individuals who have longer, more stressful commutes. Occupational stress can add to existing mental stress and worsen psychological health. Sources of occupational stress include lack of autonomy, high job demands, high workload, time constraint, lack of job security and working overtime (Public Employees Federation, 2006).

CURRENT CONDITIONS

- New Yorkers are **more likely to cite work as a significant source of stress** than an American employee in general (79% vs 68%) (The American Psychological Association (APA), 2008). More NYC workers report being stressed on a workday than workers nationally (44% vs 39%) (APA, 2008).

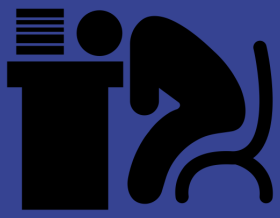
- More than half of New York City residents (56%) cited job stability as a significant stressor (APA, 2008). New Yorkers are also **more likely** than working adults in America, in general, to view **job insecurity** (45% vs 34%), **low salaries** (59% vs 49%), **lack of growth** (52% vs 43%) and **inflexible hours** (35% vs 28%) as **stressors** (APA, 2008).

- Occupational stress seems to have a **greater impact on workplace productivity for New Yorkers** than working adults in America, in general (APA, 2008). New Yorkers are also **more likely** than working adults in America, in general, **to miss at least one day of work** (30% vs 23%). Around 54% reported some **loss in work productivity due to stress** (APA, 2008).

- In terms of balancing work and family life, 28% of employed New Yorkers find it **difficult to strike a balance**, while 33% of the respondents find that **work interferes with their personal time** (APA, 2008). Nearly half of the respondents (46%) reported that their job interfered with their ability to fulfil family responsibilities (APA, 2008).

HEALTH IMPACT PATHWAYS:

Given that work is already one of the oft-cited reasons for stress in New York, it is expected that the L-train shutdown may further exacerbate the experience of occupational stress, due to the incidence of commuter stress. Given that **inflexible hours** are one of the major reasons for occupational stress among New York workers, **longer commute times** brought about by the L-train shutdown may induce **greater pressure** on the worker to reach their workplace on time, and consequently the worker may experience **higher levels of stress**. **Workplace productivity** may suffer due to these high levels of occupational stress coupled with commuter stress caused by the L-train shutdown.



HEALTH IMPACTS:

Symptoms of occupational stress brought about by the L-train shutdown may be **physical** in nature, eg. headaches, sleep disturbances, eating disorders, body pain and fatigue, and **psychological**, eg. anxiety, depression, low morale and isolation (Public Employees Federation, 2006).
Occupational stress caused by the L-train shutdown may also be correlated with job satisfaction. Job satisfaction and mental, or psychological problems are strongly associated, especially for burnout, self-esteem, depression, and anxiety (Faragher et al, 2005). Higher stress levels may negatively impact workers' mental health.

VULNERABLE POPULATIONS

The period following L-train shutdown may see a **drop in workplace productivity**, as well as more workers **missing days of work**. Consequently, the working adult may be faced with **job instability**. As seen in the baseline conditions, New York workers have reported difficulty in striking balance between work and family responsibilities, and that the former interferes with the latter. Challenges **balancing work and family** may increase when the L-Train is shut down.

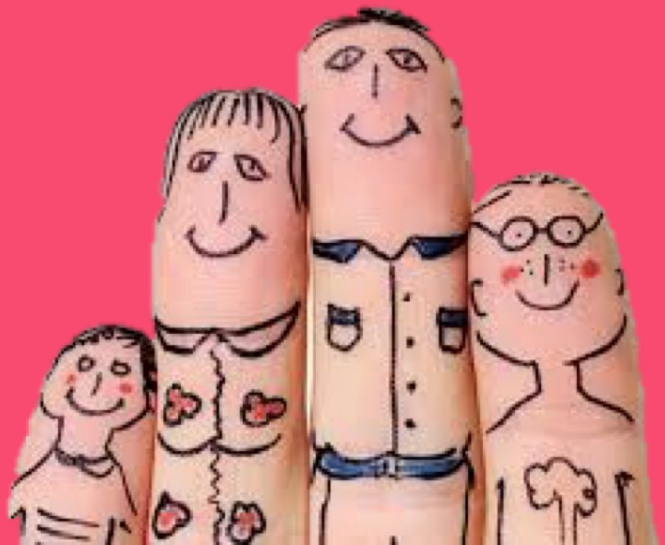
RECOMMENDATIONS

In order to mitigate the negative mental health impacts of occupational stress, the following recommendations should be considered:

- **Workplace flexibility** can contribute to **positive lifestyle behaviors** such as adequate hours of sleep and physical activity (Grzywacz, et al, 2007). Having higher workplace flexibility may lead to **higher job satisfaction**, and consequently help **reduce occupational stress**, which in turn may have positive health benefits.
- We recommend that the MTA work with employers of workers who use the L-train to get to their workplace, by communicating delays in commute to employers. This dialogue will help employers bring **staggered office hours** into effect. Workers may also be offered the option of working from home on certain days of the week. These flexible options may positively impact workplace productivity and help combat commuter stress brought about by the L-train shutdown.

FAMILY & COMMUNITY STRUCTURE

Family and community structure is a group of factors outside of a person's work life that help to define their identity in society. While the list of factors outside the workplace that influence a person's place in society is quite large, this section focuses on three that may be particularly impacted by the shutdown of the L-Train. These factors include family dynamics, the degree of a person's civic engagement, and the amount leisure time a person has available.



FAMILY DYNAMICS

WHAT IS FAMILY DYNAMICS?

Family dynamics describes the interactions between individual family members and the unit as a whole. Each family has a distinct dynamic.

Urie Bronfenbrenner published the concept of the "Ecological Model of Human Development." Ecology is the study of how things relate to each other and to their physical surroundings. In this social ecology model, Bronfenbrenner explains that we spend our time in primary "microsystems" like home and school; places where our socialization developed. But in any ecological framework, there are numerous dynamic connections; multiple ways that systems can interact. Each microsystem can affect the other, and furthermore, other systems can carryover and affect the microsystem- and vice versa (Bronfenbrenner, 1994).

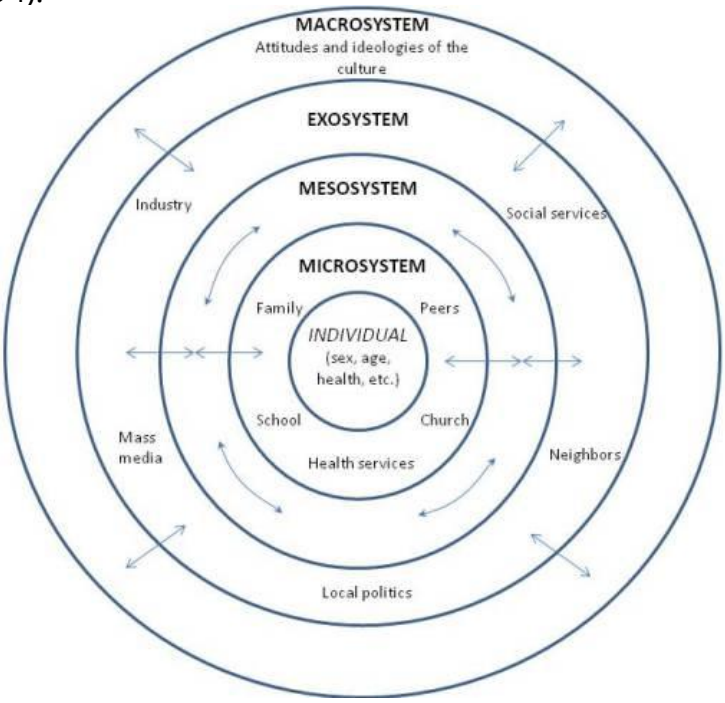


Figure 31: *Bronfenbrenner's environmental layers*

The levels of Bronfenbrenner's model are depicted above. The microsystem consists of the interactions that directly impact a person; the areas that helped socialize them. This includes family, work, school, religious institutions, and health care. The mesosystem is all the ways that the microsystem intertwines and interacts. The mesosystem demonstrates how an impact in one aspect of the microsystem can have a carryover effect to another area. These interactions are particularly relevant to the L-train shutdown, and two particular paths may be anticipated:

A. *An increase in commuting time means less time that a parent can spend at home. This inevitably means that a family will have less time to spend together which can cause a disruption to the family dynamics and heighten the stress of the children and other individuals in the family.*
B. *Additionally, the shutdown limits the access that commuters have to small family businesses along the stops of the L-train. The lowered foot traffic into these stores means less disposable income coming in, which may put an additional stress on the family, and diminish healthy family dynamics.*

CURRENT CONDITIONS:

- The average commute for a NYC citizen is already approximately three and a half times the average commute of an American (Wei 2015). Furthermore, the graphic below depicts that the average commute for NYC commuters has been greater than the average American since at least the year 2000 (Census 2000, American Community Survey 2010).

- A 2004 survey showed that commuting was listed as the least fulfilling part of the average women's day and could lead to significant mood decrease when arriving home (Wei 2015).

- A study using the American Time Use Survey concluded that after 60 mins, every hour increase in daily car commutes resulted in an approximately 22 minutes decrease in time that males spent with their wives, an almost 19 minute decrease with their children and less than 10 minute decrease with friends. For females, the same commute increase changed the time spent with friends by approximately 12 minutes, but did not change the amount of time spent with family (Christian 2012).

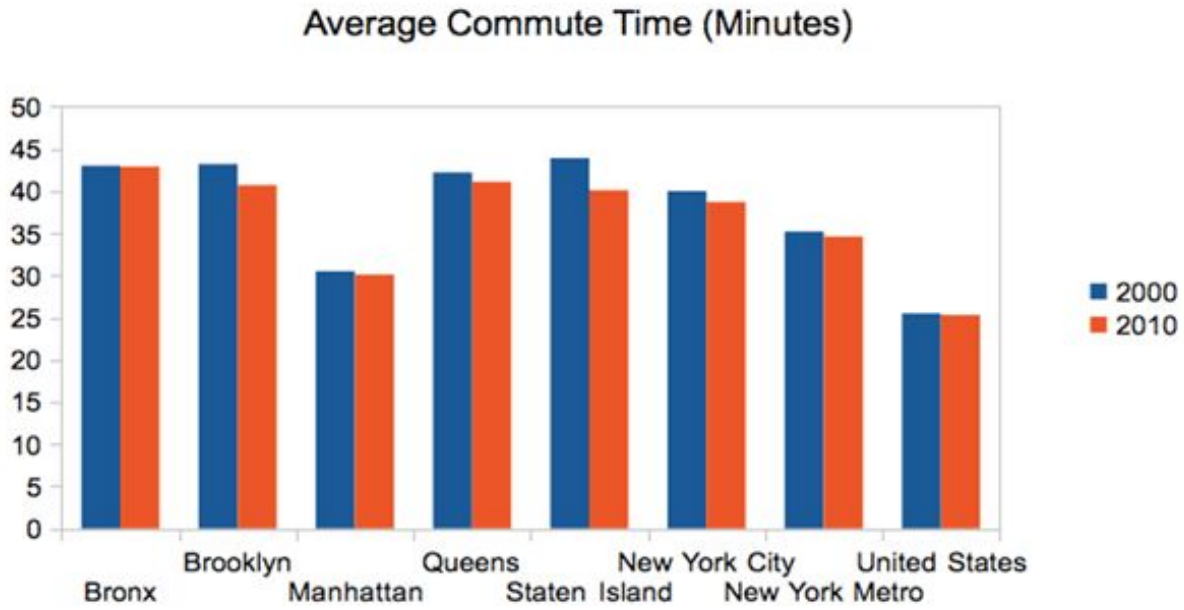


Figure 32: *Average Commute Time Table Modified from http://www.newgeography.com/content/002691-commuting-new-york-city-2000-2010 Source: Census 2000, American Community Survey 2010 1-yr*

HEALTH IMPACT PATHWAYS:

- New Yorkers live in a bustling and exciting, but high stress environment. The L-train shutdown will increase commuting time, stress, and exhaustion, which can in turn impact a person's ability to interact in a healthy manner with their family members, increasing tension and decreasing positive dynamics.

- Small business owners are concerned: Commuters from Manhattan will no longer have easy access to neighborhoods in Brooklyn that support small local businesses. Additionally, Brooklyn commuters may no longer pass through these neighborhoods, leading to a decrease in a steady flow of income (Stakeholder input from workshop, 2017).

HEALTH IMPACTS:

- As recorded in the Christian 2012 statistics, long commutes impact men and women differently. A ½ hour increase in commute is projected for many Brooklynites. This change is estimated to cause a man to sacrifice around 10 minutes everyday with both his wife and children, while a woman would sacrifice only her social interactions. This could create great familial tension .

- An increase in commuting time may decrease the number of shared family meals per week. This is linked to a decrease in the nutrition for children, and contributes to childhood obesity (Hammons & Fiese, 2011). Meals are also incredibly important places to establish family beliefs, routines, and etiquette. These can include discussions of each other's personal lives, politics, religion, and broadly help develop language skills. Without these shared family spaces, the dynamics of a family can be harmed (Spagnola & Fiese, 2007).

- Small Brooklyn businesses rely on community members and riders of the L-train for business. With less access, disposable income may decrease and cause a strain in familial relations.

VULNERABLE POPULATIONS:

- Mothers and women are often adversely affected by commuting stresses due to an increased expectation for them to be responsible in household and child affairs (Roberts et al 2011).
- Children who want more time with their parents after school

RECOMMENDATIONS:

There are some potential solutions to mitigate the stress on family dynamics brought on by the L-train shutdown. These include:

- Signs should be posted reminding passengers that it is proper etiquette to offer **seats to parents with children.**
- MTA can publish what hours of the day have **heavier foot traffic** so that family trips with small children can be easily planned for.
- Alternative routes that require physical activity should be made more **easily accessible**, as they may positively affect someone's mood before arriving home.

But most importantly, in addition to specific practical implementations, the MTA must **acknowledge the incredible stress and fatigue** that a change in commute will cause. During our visit to NYC, workshoppers said they wanted to know that the MTA was acknowledging the gravity of the change. Commuting stress is brought home to the family, and as such, it is important to tackle individual stress during the commute itself.

- The MTA can best address the emotional exhaustion of its passengers by posting signs that **acknowledge the stress** that commutes create and recommend that commuters prepare for the change in advance to combat stress levels.
- Have **advertisements** and **announcements** in subways and trains encourage commuters to engage in small acts of kindness e.g. give up one's seat, conversing with fellow commuters (Wei 2015).
- The MTA can expand the **artwork** displayed on the subway, and put up new work that promotes calm moods, positivity and thoughtfulness. For example, there was an incredibly positive public reaction to the **Poetry in Motion** campaign. Riders said that it helped improve the monotony of commutes and gave them something to look forward to. Other cities have copied this initiative (Fermino 2012).

CIVIC ENGAGEMENT

WHAT IS CIVIC ENGAGEMENT?

Civic engagement is a way for people to build a sense of community. It includes anything from an informal more personal action, such as helping a neighbor, to a more formal and public action, such as active participation in an organization or interest group (Adler and Goggin, 2005).

A study in the Netherlands found that civic engagement gave a sense of purpose and increased psychological well-being for retired people (van den Bogaard, Henkens, and Kalmijn, 2014) and another study found that immigrants and refugees also benefit from sense of belonging with active civic engagement (Weng and Lee, 2015). While civic engagement tends to decrease for those with families as they devote more time to family care rather than civic engagement, retirement brings back extra time for active civic engagement (van den Bogaard, Henkens, and Kalmijn, 2014).

CURRENT CONDITIONS

- About 80% of citizens age 18 and over living in Brooklyn are registered to vote
- 58% responded to census mail
- 9% are employed by non-profit organizations
- 13% are employed by local government
- 20% utilize NYC311 requests (information hotline provided by NYC for city services, including programs for the elderly)

HEALTH IMPACT PATHWAY:

- Shutdown may make it more difficult for people to reach and thus participate in formal/public civic engagement.
- However, shutdown may strengthen community engagement as more people may find themselves staying in Brooklyn or their neighborhoods, increasing sense of community.

HEALTH IMPACTS:

- If people cannot engage with their community, or decrease the frequency in which they do, they may feel disconnected from their communities, leading to social isolation or depression.
- Increase in civic engagement can increase people's sense of belonging and help provide sense of purpose for older adults.

VULNERABLE POPULATIONS:

- Older, retired people may feel disconnected from society if they rely on the L-train to reach their places of engagement.
- Immigrants may also feel disconnected from their social groups, especially if they are dependent on these groups to navigate and become more accustomed to their new surroundings.

RECOMMENDATIONS:

- MTA can identify key organizations or groups that have high participation and attendance and partner with them to hold moving, temporary, or **pop-up events** to bring the organizations to people rather than people having to get to their groups. While being more convenient for commuters, this may also increase **sense of community** as people within a neighborhood may meet new neighbors as they gather for community events. Additionally, participating organizations can benefit from exposure and a new audience.
- Similarly, MTA can identify various immigrant populations and work with existing cultural groups to plan **cultural workshops** to provide support or inform commuters about changes or events nearby. If groups do not exist, MTA can advertise in different languages to survey potential interest in creating new cultural groups.

LEISURE

WHAT IS LEISURE?

Leisure is most commonly defined as free time spent for enjoyment. Leisure time can include but is not limited to time spent alone, socializing with others, performing self-care routines, developing personal skills, working at hobbies, and relaxing. Leisure time is often directly impacted by the amount of time a person spends on other activities throughout the day.

CURRENT AVAILABLE LEISURE TIME OF AMERICANS:

- Over the past forty years, the number of hours that Americans have available for leisure has increased by 8.05 hours per week (Aguiar & Hurst, 2007).
- This 8.05 hours per week increase added to the previous average number of leisure hours per week results in 16.5 hours of leisure per week per person (Schor, 2008).
- This increase in hours of leisure has been shown to be larger for lower income persons and for males (Aguiar & Hurst, 2007).
- Leisure time for Americans has shifted from a great variety of activities to being primarily composed of television watching time (Aguiar & Hurst, 2007).

Breakdown of Leisure by Activity

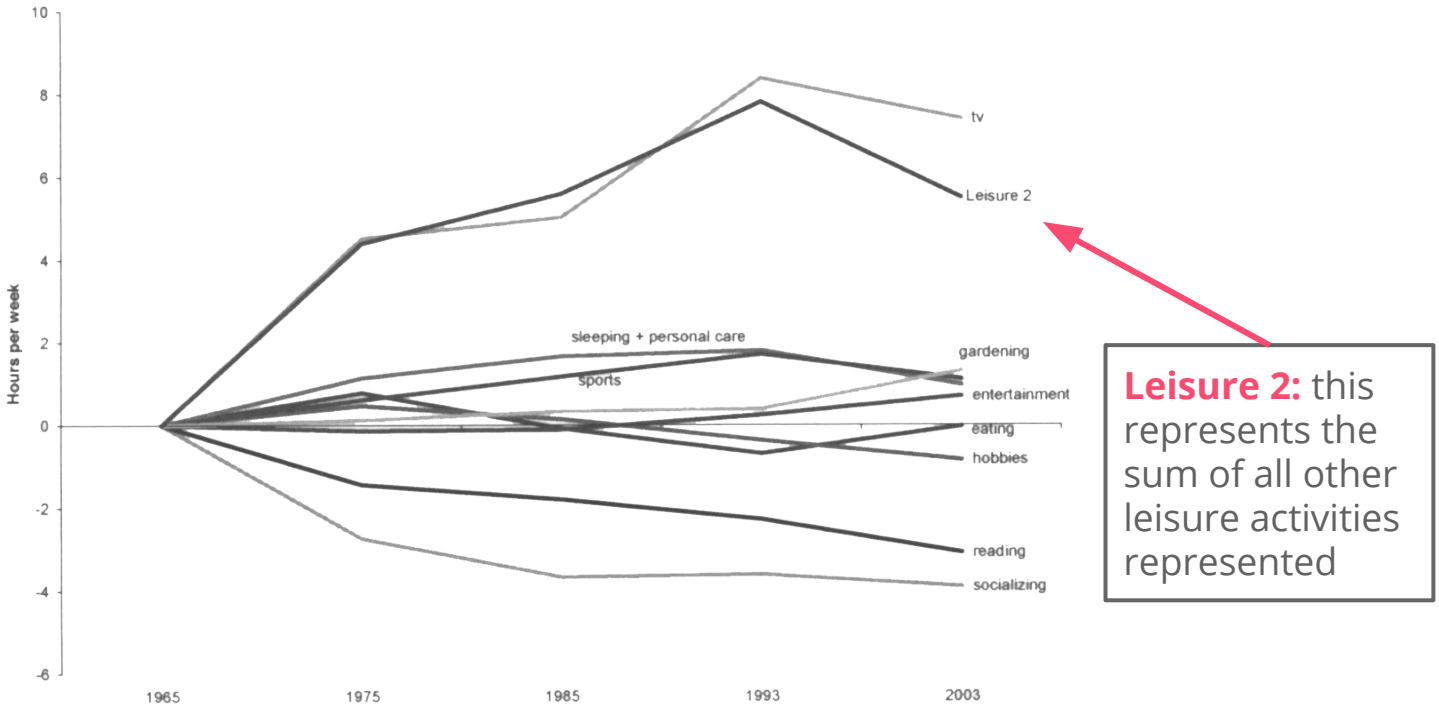


Figure 32: *Modified from Aguiar & Hurst, 2007*

HEALTH IMPACT PATHWAYS:

- Increased commute times make work days longer.
- Employees face a decrease in leisure time for socializing, self-care routines, developing personal skills, working at hobbies, and relaxing (Caldwell, 2005).
- Caldwell (2005) cites leisure as often being used as a coping mechanism for general stress, job-related stress in the form of unemployment or underemployment, and illness/disability.
- Leisure's positive impacts on mental health include providing a network for social support, providing a sense of competence derived from participation, getting the experience of challenge, having a sense of self- determination and control, and feeling disengaged from stress (Caldwell, 2005).

HEALTH IMPACTS:

- Reduced time for leisure due to an increase in commute time limits the time commuters have for exercise. This eliminates their benefits of exercise such as alleviating depressive symptoms, making individuals less anxiety prone, and making stressful stimuli appear more manageable (Dunn et al., 2001)
- Increases in commute time reduces a person's ability to socialize with others, taking a toll on their social and emotional health. This can contribute to feelings of depression.
- Not having time to develop personal skills and work at hobbies damages a person's sense of control over their time and themselves.

VULNERABLE POPULATIONS

- Historically, women have had less time for leisure activities. This is due to the higher proportion of unpaid work that women tend to do as compared to men (Sayer, 2005).
- As women still have more unpaid work than men and women are increasing their paid work, they are limited in their leisure as compared to their male counterparts.
- This difference may be small but still exists as over the past forty years leisure time has increased on average 7.83 hours for women per week and 8.29 hours for men per week (Aguiar & Hurst, 2007).

RECOMMENDATIONS

In order to mitigate the negative health impacts of reduced leisure time including increased stress, increased anxiety, increased depression, and a loss in sense of control, recommendations are focused on reducing commute times. This can be accomplished with the following objectives:

- Have the MTA and NYC DOT **communicate** with New York residents early about how the shutdown will affect them and about resources to help them navigate during the shutdown.
- Improve the efficiency of alternate modes of transportation prior to the shutdown.
    - As suggested by the residents of Brooklyn at our team's L-Train workshop, the MTA and NYC DOT should create a **bus only lane** on bridges entering Manhattan in the morning and leaving Manhattan in the evening.
    - Also suggested at the workshop was the idea that the MTA and NYC DOT have priority lanes on the bridges into Manhattan in the morning for vehicles with **high numbers of passengers**.
    - The final suggestion from this topic at our workshop was the idea to increase the frequency and availability of ferry rides; have shuttle services that make it easier to reach **ferry ports**.

4. Reporting & Monitoring

Disseminate the findings to decision makers, affected communities, and other stakeholders.

Monitor the changes in health or health risk factors and evaluate the efficacy of the measures that are implemented and the HIA process as a whole.

REPORTING & MONITORING

REPORTING

We presented our **final HIA findings** as a class to clients and stakeholders on May 10th, 2017. Our full compiled report will be disseminated to our stakeholders including Van Alen, the MTA, and the DOT upon completion to inform future decisions and mitigation strategies pertaining to the L-Train shutdown. We hope our HIA will continue to be distributed by the Department of Design and Environmental Analysis, Cornell University, and by the van Alen Institute to additional interested audiences contributing information both on HIAs and New York's L-Train shutdown.

MONITORING

For this Health impact assessment, we do not currently have the **time and resources** to follow up on the health impacts of the L-Train shutdown on the people that regularly use the L-Train. However, it would prove valuable for both the MTA or NYC DOT to:

- Distribute and collect online and mail **surveys** throughout the shutdown in order to monitor changes in user health conditions
- Hold **public forums** to gain feedback on how the alternative transportation methods provided are working and what might be improved

Conclusions

CONCLUSIONS

This HIA brings **new perspectives** on how health is intricately related to the L-train shutdown. While we recognize the great importance of the shutdown, and how deeply necessary it is to repair the damage done to the Canarsie Tunnel in Superstorm Sandy, it is also important to acknowledge the potential health impacts that the shutdown may have on the populations in Brooklyn.

Several health determinants were explored, and we hope that both the negative and positive impacts of the shutdown on health were expressed. With these impacts in mind, we proposed several recommendations to mitigate the negative impacts of the L-train shutdown while maximizing areas of positive impact.

Further steps will have to be taken now to **implement** these recommendations and monitor how well they create positive health impacts and mitigate negative health impacts.

LIMITATIONS

The timeframe of this project was very limited, spanning less than 3 months. As students, we learned what an HIA is while also conducting our HIA on the L-train shutdown. As a class, we briefly visited NYC/Brooklyn to get acquainted with the L-train, but once is not enough to develop a true understanding of the dynamics of the L-train and its commuters. During our time in NYC, we attended one of the MTA's public workshops on how the L-train may affect commuters, and conducted our own workshop in partnership with Van Alen Institute with key stakeholders.

It should also be noted that we did not have precedents to follow as no other Metro subway lines have been closed on this magnitude. This is further complicated by the fact that the L-train is a stand-alone line without a parallel route in close proximity. More time would have helped in order to conduct further research on the dynamics of commuters' movements and daily patterns to better understand the impacts of impeding L-train users from entering Manhattan from Brooklyn and vice versa.

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Appendix

LITERATURE REVIEW
Environmental Stressors: **Noise**

The Effect of Environmental Noise on Health

By: Hannah Dorpfeld

Introduction

Many studies have been conducted on the effects of environmental noise on health and well-being. The working definition for noise that most studies subscribe to is sound that is unwanted and seen as an annoyance or distraction from an individual's task at hand. Environmental noise causes adverse health effects such as early on-set hearing loss, memory loss, increase in blood pressure level, heart disease and stroke (Bilotta, Vaid & Evans, 2017). Noise is correlated with negative psychological and behavioral effects which act as mediators to health including sleep deprivation, attitudes of annoyance, low motivation and low attention levels (Evans, Hygge & Bullinger, 1995).

There are many different forms of environmental noise surrounding us at all times. Some noise sources which have been found as harmful include industrial plants, construction and maintenance work, mechanical devices, HVAC units, and vehicular traffic. The noise most frequently studied is noise from various forms of transportation (Muzet, 2007). Noise can have many different qualities and is dependent on the source how detrimental it can be to human health and behavior. Noise can be categorized as continuous (constant in the background) or intermittent (variation in decibel level or consistency), acute (one-time event or infrequent occurrence) or chronic (repeated occurrence) and controllable or uncontrollable (Bilotta, 2017). The following review will give an overview of literature which explores the effect of environmental noise on health. The review will conclude by summarizing some key findings on the importance of reducing noise stressors to elevate public health.

The Effects of Noise

In a study done on the effects of environmental noise on sleep, Muzet (2007) breaks down the effects of noise into four types: **Auditory** (fatigue, temporary or permanent deafness), **Extra-auditory** (annoyance, fatigue, low concentration), **behavioral** (medication intake, psychiatric symptoms, masking effects and learning functioning) and **biological** (sleep disturbances of cardiovascular, endocrine, digestive, growth and immune systems) (p. 137). These four categories provide a useful framework in which to think about noise and the effects it has on the individual at a conscious and unconscious level.

Learned helplessness, which includes “decrements in learning new task, diminished feelings of control, and sometimes depressive symptomatology”, falls under **Extra-auditory** effects (Evans & Stecker, 2004, p. 143). It has been found that individuals can form learned helplessness from repeated exposure to uncontrollable stimuli. This is true for noise stimuli as Evans & Stecker (2004) summarize in their comparison of studies examining both acute and chronic exposure to noise levels. They found that 14 of the studies conducted had results linking learned helplessness with noise exposure. These studies indicate that repeated noise over time can have negative effects on cognition and behavior .

An example of a cross over between **Extra-auditory** effects and **biological** effects of noise is found in a study on low frequency noise and its effects on the stress hormone, cortisol. Participants were exposed to low frequency or traffic noises as they slept. Cortisol levels were taken, decibel levels recorded, and participants subjectively reported their mood and perceived sleep quality (Waye et al, 2003). The results indicated that “continuous noise had a smaller effect on sleep quality than intermittent noise” with a threshold of normal response to awakening at 40 decibels (Waye, 2003, p. 873). To put this in perspective, 50 dBA is equal to the sound of a dishwasher in the next room and 80 dBA is equal to the sound of a garbage disposal 3 feet away. While 40 decibels seems a very low level noise to have such a strong effect on cortisol awakening responses, the significance lies in the quality of the noise. It was suggested that a continuous low level noise, while it may be at a decibel level which evokes a cortisol waking response, could enter the individual into a stage of resistance instead of an alarm reaction evoked by a repeated intermittent noise. The sample size of this study is small and more studies should be done to confirm this correlation. However, they are significant given that a specific decibel level was found which evokes cortisol reaction and participants’ behaviors modified this response in the exposure to a continuous noise vs. an intermittent.

Stansfeld et al (2005) studied the effects of aircraft noise on children’s cognition and health and indicates how noise causes **behavioral** effects including learning functioning. The findings indicate higher aircraft noise decibel levels correlate with delays in reading comprehension across countries. The longest delay was in the UK with a 5 decibel increase in aircraft noise equated to a 2 month reading delay. These findings show negative associations between aircraft noise and recognition. No significant correlation was found for information recall, conceptual recall, working memory, prospective memory or sustained attention. However, additional studies have found ambient noise from various traffic forms to be detrimental to children’s classroom performance and health by measuring reading comprehension, recognition memory, standardized testing and biological quality of life indicators (Stansfeld, et al., year; Evans, Hygge & Bullinger, M., 1995; Evans, Bullinger and Hygge, 1998).

Stansfield found an increase in annoyance, a psychological factor which can be detrimental and cause stress, but found no correlation to a decrease of mental health. This causes questioning as to whether or not previous studies were using adequate metrics for studying the effect of noise on mental health. Additional studies should be done with more in-depth questionnaires on mental health for the participants.

In a study on physiological response, children exposed to an increase of ambient, uncontrolled noise from aircrafts flying over their school were found to have significant increases in resting blood pressure and decreases of perceived quality of life (Evans, Bullinger & Hygge, 1998). This is an example of **biological** effects of environmental noise. In addition to increases in resting blood pressure, children in schools within the flight paths had increased levels of epinephrine and norepinephrine, adrenaline hormones released in a fight-or-flight response. This finding is significant to health as more studies are finding the effects of chronic stress on the body with blood pressure and stress hormones as indicators.

Noise stressors and public health

The studies so far discussed are those which have focused on the individual's experience and the effect of environmental noise on the auditory, psychosocial, physiological and mental health. Until recently, not many studies have examined the effect of noise on population health. The studies of noise have shown that not only are there hearing loss risks to high decibel noise exposure but also risks of chronic stress accumulation. Chronic stress is a common topic in public health now and noise is beginning to be studied from the perspective of public health, asking how the soundscape of urban settings may be influencing the health of residents. The amount of America’s population living in urban settings has been rising steadily since the 1960s and with the increasing urban population there has also been an increase in prevalence of noise-producing machinery and vehicular miles traveled (Moudon, 2009). All of these factors are leading urban populations into increased environmental noise if policies or infrastructure does not change. While some organizations responsible for abatement of noise levels in urban communities such as World Health Organization try to mediate the effects of the urban soundscape by recommending their riders wear personal hearing protective equipment, more studies should be done on noise and its relationship to public health and chronic stressors (Neitzel et al., 2009). In addition, more studies should be conducted on the effects of everyday levels of noise. One such study has been done on children in rural Austria. The results indicated that compared to children living in more rural areas, children who lived noisier areas are more subject to stress based on comparison of resting blood pressure and cortisol levels (Evans et al, 2001). This study reveals something that should not be taken lightly by public health professionals, city planners and social activists: that noise-induced stress can be affected by what area an individual resides in and that chronic stress can affect their overall health and well-being.

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LITERATURE REVIEW

Environmental Stressor: **Crowding**

The Effect of Crowding on Human Health

By: Chloe Collins

Introduction

Urban areas are prone to issues of crowding. Crowding occurs when the space allotted contains too many people for comfort. There are several nuances in the definition for crowding, but generally it is important to note the distinction between crowding and density. Density is typically viewed as the number of people per given area, but crowding is a psychological construct based on perception (Boots, 1979). In some definitions, density is seen as an external objective measure, whereas crowding is within the home and a perceived measure (Boots, 1979).

The effects of crowding are not uniform. In terms of residential crowding, individuals of a lower socioeconomic status (SES) are more vulnerable to this stressor because crowding is often coupled with poorer housing quality (Evans, 2004). Poor housing quality can also be associated with noisy conditions and increased levels of air and water pollution, which may exacerbate the effects of crowding. Children are also quite vulnerable to crowding. Studies show that crowding may have an influence over cognitive development (Evans et al., 2010). Crowding has also been linked to social mechanisms and psychological impacts (Regoeczi, 2003). For example, crowding has also been linked to aggression outside of the home and internally within a family unit, as well as, social withdrawal and isolation (Regoeczi, 2003).

Crowding on transit is a bit different than household crowding. It often has to do with the proximal distance between people. Often, on public transit, the actual level of social interaction exceeds the level of desired social interaction (Evans, & Wener, 2007). This impact may be enhanced in individuals facing chronic residential crowding (Evans, & Wener, 2007). Crowding on transit is correlated with behaviors limiting social interactions, the bystander effect, and less altruism in public domains (Milgram, 1970). This literature review will examine the complex relationships between crowding and withdrawal, crowding and aggression, and crowding and transit.

Crowding + Withdrawal

Environmental stressors are external stimuli that cause discontent such as: noise, crowding, and air pollution (What is Environmental Stress?). Crowding is a complex environmental stressor that can be linked to nearly all parts of daily life. Living in cities, crowding

on transit, and household density are different aspects of crowding that may have differing impacts. Living in cities and household densities is associated with withdrawal-based coping mechanisms designed to regulate unwanted social interaction. The anonymity and impersonality of city dwellings has been tied to diminishing social support mechanisms. Finally, chronic household crowding is often correlated with compounding environmental stressors, such as, poor housing quality, noise, and air and water pollution that may affect certain sub-groups more heavily than others.

Behaviors to Limit Social Interaction

Social withdrawal and aggression are possible coping mechanisms to mitigate the effects of crowding (Regoeczi, 2003). Social withdrawal is seen as occurring to adapt to crowded environments. Studies suggest that individuals use withdrawal mechanisms when there is a stimulus overload brought on by excess people. Individuals will "tune out" or withdraw in effort to regain control over the situation in crowded social scenarios (Regoeczi, 2003). One study suggests that people living in crowded situations have a poorer memory for social information and details than their less crowded counterparts (Evans et al., 2000). There is also the idea that sometimes aggression and social withdrawal may operate together. For example, an individual may appear aggressive to avoid unwanted social interaction (Regoeczi, 2003). Regardless of the coping mechanism or combination of coping mechanisms, crowding has been demonstrated to have potentially negative social and psychological effects on individuals.

Miligrim describes the complicated set of social interactions that affect people living in cities, in "The Experience of Living in Cities" (Milgram, 1970). The conditions Milgrim describes in a city are threefold, first he notes the large number of person-to-person encounters, second the population density, and third the heterogeneity of the population. These factors deter social interaction in fascinating ways. He suggests that crowding provides a certain level of stimulation overload that results in adaptive mechanisms to avoid unwanted social interaction. These mechanisms include: limiting the amount of time spent on inputs, disregarding low priority inputs, limiting some social transactions, and blocking social encounters. Some examples Milgrim includes are: unlisted telephone numbers and limiting social transactions with the use of exact change on buses. Milgrim states that moral and social responsibilities may be diminished in cities.

Common courtesies such as apologizing after running into someone and offering one's seat to a stranger may be forgone due to this stimuli overload. He suggests that the "bystander effect" is especially strong in cities meaning that city dwellers are less likely to step into crises or situations with victims. He also suggests that city dwellers may be less trusting, helpful, and civil to strangers, than members of small towns and communities.

Crowding + Social Support

Continual anonymity in cities and crowded communities provides for some interesting social dynamics. Unlike in small towns, city dwellers, pedestrians, and transit users alike can leave their homes with a relatively low probability of encounters with acquaintances. This impersonality of daily life allows for a lot of self-expression and privacy of affairs that is not often seen in small towns. There are less imposed norms on city dwellers such as dress code or behavioral patterns, than members of small towns experience (Milgram, 1970). City dwellers unlike small town residents are more able to keep their affairs private and have a private life; however, the anonymity of cities also can lead to feelings of isolation and impersonality (Milgram, 1970).

There is evidence to suggest that high residential crowding may be correlated to different social information processes (Evans et al., 2000). Chronically crowded residents both in natural and lab conditions were observed to have poorer social memory and were less cognizant of personal information pertaining to strangers (Evans et al., 2000). Residents living in chronically crowded conditions were found to tune out social and personal information, a trend that could affect socio-emotional development in children (Evans et al., 2010). Children are often vulnerable to the spill-over effects of crowding. Spill-over effects or negative impacts from stress that carry over into other domains of an individual's life, such as, at home or work, can ultimately affect familial relationships and friendships. This can be particularly true in populations vulnerable to environmental stressors. In addition repeated or habitual coping mechanisms, like social withdrawal may contribute to strained relationships and deteriorated social support systems, for overcrowded residents.

Crowding + Cognitive Development

Children are particularly vulnerable to the harmful effects of crowding. Negative effects of crowding include: elevated psychological stress, behavioral problems, and delayed cognitive development. Starting in infancy, children in more crowded homes tend to show lower levels of cognitive development (Evans, 2010). There appears to be a strong link between crowding and maternal responsiveness. Children in crowded households tend to have less responsive mothers and often lowered cognitive development. Children in crowded households also face an additional myriad of problems in addition to crowding, including: noise and poor building quality (Evans, 2006). This idea of multiple environmental stressors is a prominent principle of environmental psychology and that certain sub-groups of the population, such as, low income individuals, individuals with disabilities, children and the elderly are particularly vulnerable.

Crowding + Aggression

Crowding is not a topic intended to be isolated from withdrawal behaviors, but rather an extension. People can be aggressive and avoid social interaction or use aggression as a mechanism of withdrawal (Regoeczi, 2003). Much of the general data discussing crowding and aggression is based on crime statistics and population density (Regoeczi, 2003). There is a general correlation between crime rates and population density, which is particularly true in terms of violent crime and juvenile crime (Regoeczi, 2003).

Regoeczi's study analyzes the complicated interactions between residential or internal density and neighborhood or external density, in addition to the complex relationship of aggression and withdrawal. Ultimately, Regoeczi sees aggression and withdrawal as coping mechanisms to combat crowding. She suggests more work ought to be done to understand aggressive and withdrawal behaviors across different demographics, such as, income or gender. She also suggests that there may be an "ideal range" of internal and external density in which negative effects of crowding are mitigated (Regoeczi, 2003).

Crowding on Transit

Crowding on transit is slightly different than neighborhood or residential density. Evans and Wener (2003) suggest that proximal distance may be more a more salient measure on public transit than distal or spatial density. This means that the measure of distance between passengers is more of a concern than the number of passengers in the car. A potential explanation for this finding is the idea of personal space. People tend to have a desired level of social interaction and if this level is exceeded, individuals may become stressed and anxious. Measures to test this stress include physiological tests, self-assessment, and persistence and accuracy tasks (Evans & Wener, 2007). Commuters are the primary affected sub-group when discussing the stress of public transit. Evans and Wener assessed one hundred and thirty-nine New Jersey commuters to determine how transit affects stress. To measure physiological stress, researchers collected salivary cortisol from participants after their morning commutes. This measure was run through a series of procedures to predict stress hormone levels. Ultimately, researchers found that proximal distance was highly correlated to stress, while a distal index was not (Evans & Wener, 2007). To measure the aftereffects of transit commuting, Evans and Wener measured participant's persistence on a proofreading task (Evans & Wener, 2007). Proximal distance was a factor in this measure in addition to measures of mood and overall levels of life stress. The middle seat was particularly egregious for commuters and negative effects were amplified. They discussed

several possible explanations for the stress levels, including: perceived boundary and personal space intrusion, and the risk of germs and possible infection.

Conclusions

Crowding is a complex environmental stressor, which must be considered with a myriad of other variables. When discussing vulnerable populations it is very important to note the potential for compounding variables such as multiple environmental stressors and spillover effects from other stressful stimuli. Children and individuals of lower SES are particularly susceptible to multiple environmental stressors and thus are often more strongly impacted by crowding than individuals with better housing and more control in their jobs. There is some evidence to suggest that individuals may experience aggression and social withdrawal in correlation with chronic crowding. Crowding on transit is more a matter of social distance than matter of social density, but is important to address as impacts of residential crowding may be linked to impacts of crowding on transit. Crowding may account for some health implications that salient in our communities today.

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LITERATURE REVIEW
Mobility: **Walkability**

Improving Human Health by Maximizing Neighborhood Walkability

By: Janine Mazur

An area's perceived walkability is described as how friendly it appears to be for walking. How walkable a neighborhood appears to be is often measured with a Walk Score™, a numerical value incorporating both neighborhood density and access to nearby amenities (Carr et al., 2010). Walkability is becoming increasingly important in the realm of public health, as a higher Walk Scores™ have been linked to certain health impacts for residents. Higher walkability indices in particular are associated with lower Body Mass Indexes and less abdominal adiposity (Frank, 2006; Sriram, 2016). Increased walkability has additionally been associated with lower incidences of type 2 diabetes (Sundquist, 2015). These positive health effects of walkability go beyond physical manifestations and have been shown to mitigate symptoms of depression as well (Berke, 2007). Thus, walkability is a vital factor to consider in neighborhood planning as it has far reaching effects on human physical and mental health. In order to maximize these benefits, it is important to understand the physical factors of a neighborhood that improve perceived walkability. The three most common of these factors include the population and employment density of an area, the diversity of places available in a neighborhood, and the design of a neighborhood's walkways (Rattan et al., 2012). The following draws from existing literature and outlines important elements from these three areas to incorporate into neighborhood planning. Ideally, with the incorporation of these elements into neighborhood planning, residents of those areas will reap the physical and mental health benefits.

The first factor to consider when designing for walkability is the population and employment density of an area. These densities are defined as how many people live and work within a certain spatial radius. In a paper by Saelens, it is noted that population and employment densities are positively correlated with walking for both the purposes of commuting and shopping (Saelens, 2003). Thus, the closer necessary resources are, the more likely people are to use walking as their mode of travel to various destinations. Not only are residents more likely to walk if population and employment densities are high, but they are also less likely to use other modes of travel. A study performed by Glazier showed that the high levels of resident density and the availability of walkable destinations was associated with the lowest levels of automobile trips (Glazier, 2014).

This research points to the idea that when walking is compared with other travel options, it is usually only appealing for fairly short distances. Leslie et al. suggests that in order to maximize walking among residents, most amenities including place of residence, shops, employment, and regional transit service, should aim to be within a half mile of each other (Leslie et al., 2007). Such an arrangement would improve perceived walkability and hopefully as a result improve actual amount walked and resident health.

An equally important environmental factor to consider in improving walkability is the diversity of land usage in a neighborhood. This is illustrated by Christian et al.'s study that showed different walkability scores for the exact same neighborhood. The walk scores differed for the same location when different combinations of land usage types were included in calculating the walk scores (Christian et al., 2011). The general trend from that study suggests that with greater diversity of land usage comes greater walkability. A paper by Saelens reinforces this idea, noting that areas with close proximity to shopping, work, and non-residential land usage had higher levels of walking and biking for residents (Saelens, 2003). Supporting the incorporation of mixed land use will be an especially important factor for improving walkability and thus resident health. This is due to the trend in modern-day land ordinances where residential and other land uses are often kept separate. Without mixed land usage, the paths between common destinations are often far too large to be a reasonable walking distance (Frank, 2006). It would likely be easy to accomplish mixed land usage in an area that also incorporates the first principle of designing a neighborhood to be dense in terms of population and employment. The combination of the two would especially have a positive impact on an area's walkability.

The final physical factor impacting walkability is the design of walkways and neighborhood structures. Of particular importance is the availability of greenery throughout neighborhood walkways. A study by Neckerman showed a decrease in physical activity in neighborhoods with fewer trees (Neckerman, 2009). The absence of trees in walkways compounds negative health impacts. Having less greenery decreases how much residents walk and limits the benefits that they receive form being exposed to greenery. Being exposed to vegetation has been noted to contribute to stress mitigation (Fan, 2014). Beyond the greenery around walking paths, the general design and upkeep of buildings along walkways has a significant impact on a neighborhood's walkability. Foster notes that houses with features suggesting natural surveillance are likely to increase walkability (Foster, 2011). Balconies imply that people will be spending time outdoors and might see passersby; low border walls around the perimeter of a house suggest that people in the neighborhood are concerned about security. These features place an emphasis on safety and along with well-kept properties,

they suggest a low probability of incivility or crime (Foster, 2011). This notion is further reinforced in Neckerman's study which notes improving aesthetics and safety conditions in poorer neighborhoods as an effective method of improving health disparities related to physical activity (Neckerman, 2009). Neighborhoods that boast many natural features and well-kept properties support feelings of safety, improving their walkability.

Perceived walkability directly influences a person's willingness to walk rather than utilize other forms of travel. Learning how to leverage elements such as a neighborhood's population density, diversity of land usage, and walkway design is vital to improving walkability. Improving community walk scores by utilizing this information is likely to have a positive impact on both the physical and mental health of residents. These healthier individuals, as a result, are more likely to perform their best, have positive interactions with others, and strive to improve the quality of life within their community further. Healthy habits are contagious and improving walkability in a neighborhood is a great way to help people catch the bug.

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LITERATURE REVIEW
Health-Related Behaviors: **Physical Activity**

Environmental Effects on Children's Physical Activity
By: Krishna Shah

One in five school-aged children between the ages of 6 and 19 are obese. Defined by the CDC as "having excess body weight for a particular height from fat, muscle, bone, or water," childhood obesity has been linked to long-term physical and mental health issues including chronic heart disease, diabetes, asthma, depression, and low self-esteem (Healthy Schools, 2017). There are several elements that can affect childhood obesity and child health. Physical activity is one such factor; studies suggest that children should engage in at least sixty minutes of moderate to vigorous physical activity daily (Hills et al., 2015). However, there are barriers that can prevent children from being physically active.

Many environmental factors affect the feasibility of physical activity. Access to recreational facilities and outdoor areas can pose the greatest limitation to physical activity. Children need parks, gyms, and activity centers to maintain a level of physical activity (Hills et al., 2015). Additionally, the design of neighborhoods can affect physical activity. The "walkability" of communities refers to the ability for people to access resources via pedestrian pathways without danger or risk, while the "sprawl" refers to the density of homes and resources in areas (Maddison et al., 2009). These can affect whether a child can properly access different resources on foot and whether those facilities are located at reasonable distances. All of these environmental factors have important contributions on childhood physical activity, as access to facilities and outdoor areas and community design can either promote or hinder children's health. Significant literature has been dedicated to these contributions, and the following review will offer a high-level summary.

Access to areas that promote physical activity is a significant contributor to children's health. These areas include recreational facilities such as gyms, outdoor areas, and childcare centers promoting physical education (Henderson et al., 2015). Access is defined as having one of these structures readily available in a child's immediate community (Alexander et al., 2013). Research shows that children who are not within 500 meters of a public park or 10 kilometers of a public recreation program were 8-9% more likely to be overweight and 2-3% more likely to be obese (Wolch et al., 2011). Access to public recreation programs and facilities was found to especially affect BMI in young children; those with access had BMI measures that were 1.5 units smaller than those children without access (Wolch et al., 2011). Similar studies have looked at the

link between physical activity and outdoor areas in a child's immediate neighborhood. Research has found that children with at least one outdoor area in their community had 0.79 times the prevalence of obesity than those who had zero (Alexander et al., 2013). That is to say, parks and other play areas help to decrease the likelihood of childhood obesity. This is most likely because of the possibilities for physical activity that emerge from having such play areas. As studies have shown, physical activity can encompass a broad range of exercises, from structured play to unstructured time moving outdoors, thus, spaces that children can access are important. Further, recreation centers and parks have been linked to important features of child development. Neighborhoods with green spaces such as parks and open land are positively associated with domains of physical health, wellbeing, and social competence (Christian et al., 2015). Thus, outdoor spaces and gyms are important contributors to health and their placement must be considered when planning communities.

Beyond outdoor areas and gyms, research has also shown that childcare centers that incorporate activity into their routine also affect children's health. Centers can contribute to 14-47% of the variance in physical activity, as they offer structured play times that increase daily movement (Henderson et al., 2015). However, only about 60% of children are enrolled in such centers. Children without access to a childcare center sacrifice nine to 27 minutes of additional activity a day. With the required amount being sixty minutes of moderate activity, this can leave a child without significant physical exercise each day (Henderson et al., 2015). Although there are multiple barriers to enrollment, communities should work on ensuring the placement of low-cost centers in their towns. Additionally, parks and other recreational facilities should be located within a child's neighborhood. As the Alexander et al. paper found, just one such structure significantly lowered the risk of obesity (Alexander et al., 2013). These areas offer venues for children to engage in exercise, so without facilities on hand in their neighborhoods, kids will not engage in the sufficient physical activity needed to maintain health and prevent obesity. Therefore, when planning neighborhoods, it is important to ensure that there is at least one park, gym, or childcare center in the community, as it will offer significant beneficial impacts on children's health.

In addition to access to facilities, neighborhood design also affects the level of physical activity a child can engage in. While a neighborhood may have the appropriate facilities on hand, the roads and distances to these structures can pose limitations. The layout of streets, as well as placement of traffic lights and density of buildings, can all contribute to how easy it may be for a child to simply walk around or reach these destinations (Kurka et al., 2015). The layout especially refers to the walkability, while the density refers to sprawl. Studies have been conducted to examine different combinations of factors involving walkability, safety, and density. These measures were evaluated via parent questionnaires for the most part; parents were asked to

rate how safe they felt it was for their children to walk alone in terms of traffic and crime safety, to rate the street connectivity, and to rate how far they felt their children had to walk. While researchers admit this form of evaluation presents limitations, for the most part, succinct profiles of neighborhoods were created (Kurka et al., 2015). In the neighborhoods with the lowest walkability, safety, and density as ranked by parents, children engaged in 13 fewer minutes of moderate-to-vigorous physical activity per day than children in communities with higher rankings (Kurka et al., 2015). These low-ranked communities offered fewer options for safer pedestrian travel, thus contributing to increased sedentary time in moving vehicles. Additional studies have corroborated the theory that neighborhood design affects children's physical activity. Less connected streets as defined by having to have children cross multiple crosswalks and less street lighting has been linked to lower playtime for children (Christian et al., 2015). Further, in a study similar to the one conducted by Kurka, researchers evaluated the proximity to recreational facilities and parks, as well as the perceived safety parents felt their children had commuting alone. Similar parent reports were used and findings related to how neighborhood layout affected children's autonomy and travel times. Better reported safety from crime, higher neighborhood aesthetics (safer crosswalks, cleaner streets), and better pedestrian pathways increased children's activity by at least two days per week (Tappe et al., 2013).

Neighborhoods with higher aesthetics in terms of cleaner looking buildings and nicer streets experience increased park attendance, as parents were more willing to bring their children. Additionally, neighborhoods that had clear traffic rules and designated walking and biking lanes were perceived as more attractive by parents, making it more likely that they would allow their children to play outside or walk alone to recreational areas (Tappe et al., 2013). Essentially, neighborhood layout affects children via parents, as the perceived safety and ease of access affects a parent's decision to allow children outside. It affects the level of autonomy by which a child can engage in physical activity, thus community planners should consider placing streets in an organized fashion, employing sufficient traffic lights, and ensuring that there are clear paths to designated recreational facilities.

Physical activity in children is influenced by several environmental factors that can either promote or hinder well-being. As substantial research has shown, access to facilities as marked by distance and presence in a community can affect whether a child engages in the recommended sixty minutes of exercise a day, while the layout of neighborhoods can affect the autonomy by which a child can engage in outdoor play or travel to relevant facilities. These environmental factors can affect physical activity, which in turn affects children's obesity and health. There is an important link between exercise and health, so it is important that policymakers and urban planners consider the placing of parks, gyms, and childcare centers when planning neighborhoods. Additionally, features such as traffic lights and crosswalks must

also be considered. Further research could be done in this field to better establish parameters for urban planning; exact distances and locations for such structures may offer better guidelines for officials. At this time, however, it is important to note how influential the environment can be on children's physical activity, as childhood development is an important predictor for later well-being. Thus, further studies can have lasting impacts on increasing physical activity in children, in order to moderate the prevalence of childhood obesity and improve health overall.

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LITERATURE REVIEW

Health-Related Behaviors: **Diet**

Neighborhood Food Environment's Impact on Eating Behavior for Low-SES Population

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Introduction

Neighborhood food environment, or availability, accessibility, and affordability of healthy foods within a community, has long been associated with the risk of poor nutrition and obesity (Morland, Wing, & Roux, 2002; Hill & Peters, 1998). Similarly, low socioeconomic status (SES) is closely linked to negative health-related behaviors, such as tobacco use, physical inactivity, and poor nutrition (Pampel, Krueger, & Denney, 2010). As reviewed by Pampel et al. (2010), the correlation between low-SES population and unhealthy behaviors can be explained by diverse underlying causal mechanisms, including high stress as well as lack of knowledge and access to information about health risks. Low-SES populations are more likely to live in disadvantaged neighborhoods with less access to healthier foods, making them vulnerable to unhealthy food environment that lead to poor nutrition and diet. Research suggests that compared to high-SES people who live in resource-rich neighborhoods, low-SES people in resource-poor neighborhoods have more difficulty adhering to healthy life styles (Sloane et al., 2003). Understandably, the neighborhood food environment has a significant impact in shaping the eating behavior of its residents, and accordingly has the latent opportunity to promote healthy behaviors for the vulnerable low-SES populations.

In an effort to understand the community impact on people's dietary behaviors, this literature review will look into the geographic and financial accessibility to healthy food related to eating behaviors as well as some best practices for remedies in the deprived neighborhoods. This review specifically focuses on the disparities in food accessibility for low-income and minority groups that comprise the low-SES populations.

Supermarket Availability

Geographic access to healthy food entails availability of local retail outlets carrying quality product mix. The emergence of urban "food deserts", areas within city centers where low-income people have poor access to vegetables, fruits, and other whole food, has become rampant over the past few decades (Mead, 2008). According to the U.S. Department of Agriculture's food desert study, approximately 23.5 million people cannot access a supermarket within one mile of their homes (Ver Ploeg et al., 2009). Moreover, a national study revealed that low-income areas had

only 75% as many chain supermarkets compared to middle-income areas (Larson, Story, & Nelson, 2009). Another study by Moore and Diez-Roux (2006) found that low-income neighborhoods had four times as many non-chain grocery stores and half as many supermarkets compared to higher-income counterparts. A study that examined relative changes in availability of various food stores by race and SES from 1997 to 2008 revealed that predominantly African-American neighborhoods and low-income neighborhoods had the smallest increase in food store availability and the greatest reduction in grocery store availability (Powell, Han, & Chaloupka, 2010).

Supermarket shortage in low-SES neighborhoods means lack of access to healthy foods, since supermarkets have become the major access points for fresh produce. While there exist a wide variety of retail outlets today, supermarkets or supercenters account for 90% of Americans' grocery shopping (USDA, 2015, as cited in Schmitt, 2015). Supermarkets have healthy food options available at lower prices than smaller grocery or convenience stores. Low-SES populations living in low-income areas that lack access to supermarkets inevitably suffer from the limited access because they shop where food prices are lower whenever they can (Ver Ploeg et al., 2009). According to Larson et al. (2009), an analysis of relevant research studies found that neighborhood residents who have better access to supermarkets and limited access to convenience stores are more likely to have healthier diets and lower levels of obesity.

Healthy Food Availability

Along with food store access, in-store availability of healthy foods is an important determinant of residents' healthy food choices, especially for urban neighborhoods with higher concentration of small food stores. Bodor, Rose, Farley, Swalm, and Scott (2008) surveyed a random sample of 102 households in central-city New Orleans, and discovered that greater fresh vegetable availability within close proximity (100m radius) of a residence was a positive predictor of vegetable consumption, which is often used as a good measure of healthy eating behavior. Fruits and vegetables were consistently the most frequently occurring definition of healthful eating regardless of income, race, or sex (Eikenberry & Smith, 2004). According to the results from self-administered surveys of low-income subjects (n=796) in Minnesota communities conducted by Eikenberry and Smith (2004), time (48.8%) was the biggest barrier to healthy eating, indicating the significance of geographic accessibility or proximity of healthy food in encouraging healthful eating. Cost (38.5%) and money situation (38.5%) were also top barriers for low-income urban and rural populations; however, for white and higher-income groups, affordability was not as important a barrier as time, discipline, and laziness (Eikenberry & Smith, 2004).

Transportation Accessibility

Accessibility to transportation system is also a concern that affects people's access to healthy food. As Gilliland (as cited in Mead, 2008) notes, despite the widespread assumption that accessibility is universal in the age of automobiles, there is the need to recognize problems faced by people without automobiles—those who rely on other modes of transportation. According to the USDA's 2015 survey (as cited in Schmitt, 2015), most people drive their own car to pick up the groceries, but lower-income households are more likely to rely on public transit or a ride. Despite low-income families' reliance on public transit to get their groceries, the transportation system is often not catered towards urban residents' travel routes to shopping destinations, since the transit is primarily set up to help commuters get to work (Gottlieb, Fisher, Dohan, O'Connor, & Parks, 1996). As reviewed by Walker, Keane, and Burke (2010), multiple research findings revealed that low-income residents without access to personal vehicle for transport to supermarkets outside their immediate neighborhood tend to suffer more from the lack of healthy food options, as they are inclined to opt for more easily accessible fast-food restaurants and corner stores.

Fast Food Accessibility

Poor and minority neighborhoods with disproportionate populations suffering from obesity, diabetes, and other foodborne chronic conditions, are closely associated with ease of access to fast food, or "readily available, relatively cheap, high-fat, calorie-rich food" (Gordon et al., 2010). Gordon et al. (2010) conducted a study examining neighborhood food availability and accessibility in low-income and wealthier neighborhoods of New York City through a methodological approach that assigned scores according to the three factors: access to supermarkets, bodegas carrying healthy foods, and fast food restaurants. The assessment resulted in the lowest negative scores within East and Central Harlem and North and Central Brooklyn, the neighborhoods with the highest proportions of Black residents and the lowest median household incomes, whereas the most favorable scores were on the Upper East Side, a predominantly white, middle and upper-income area (Gordon et al., 2010). The findings from the study confirmed the health disparities pronounced in low-SES neighborhoods with food environment lacking with healthy options.

Community Opportunities

Story, Kaphingst, Robinson-O'Brien, and Glanz (2008) note that environmental and policy interventions may be among the most effective strategies to improve eating behaviors for the entire population. As illustrated by the extensive literature reviewed above, health disparities are prevalent in urban neighborhoods as low-SES populations significantly suffer from the limited geographic and financial accessibility to healthy food. Two guiding principles in improving the situation would be to improve accessibility (1) by bringing the healthy food to the low-SES neighborhoods, or (2) by bringing the low-SES households to the healthy food.

An example of the first approach of bringing the healthy food closer to disenfranchised groups includes mobile markets or pop-up local farmer's markets. Gilliland (as cited in Mead, 2008) recommends a "mobile market" that visits various neighborhoods throughout the week to offer increased access to healthy foods. Another best practice of improving access includes supermarket-sponsored shuttles that can self-support and provide service in low-income urban areas (Cassady & Mohan, 2004). In order for these provisions to be successful, cities should support planning policies that promote healthy behavior for low-SES population while offering grocery retailers incentives to participate in changes for healthier communities.

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