Potential risks and user preferences of helmet-sharing program provided by Vancouver's Mobi bike-share program

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ABSTRACT

Background: Mobi is a bike-sharing program in Vancouver, BC that provides helmets for use with each bike. There is little research documenting risks associated with helmet-sharing, but an evidence review has shown that there is the potential for transmission of diseases that are known or presumed to be transmitted via fomites. This study attempted to ascertain public opinion of helmet-sharing and whether concern over the cleanliness of shared helmets affected likelihood of wearing them.

Method: A survey was conducted to determine if there is a relationship between concern with helmet cleanliness and likelihood of wearing shared helmets. The researcher conducted surveys in-person at randomly chosen Mobi docking stations. An online (SurveyMonkey) survey was also distributed using Facebook, Twitter, Reddit and email.

Results: Chi-square tests performed using NCSS determined that there was a statistically significant association between helmet use on personal bikes and use of Mobi helmet when riding Mobi bikes ($p=0.00029$). There was also an association between whether users found cleanliness the most important factor in their decision to wear the Mobi helmet (of cleanliness, aesthetics, legal requirement, safety and comfort/fit) and likelihood of wearing the Mobi helmet ($p=0.02038$). There was no association found between level of concern for cleanliness of the helmet and likelihood of wearing it ($p=0.54995$).

Conclusions: Based on the results, there is an association between concern with the cleanliness of shared helmets are and how likely users are to wear them. Users that were most concerned about safety were more likely to use the Mobi helmet during every ride. Those that were most concerned about cleanliness were least likely to wear the Mobi helmet. However, this study also concluded that some users chose not to wear the provided helmets for reasons other than concern for cleanliness. Further research is required to determine how this will affect the health and safety of Mobi Bike users.

Keywords: helmet, bike-share, helmet-share, bicycle

INTRODUCTION

Bike-share programs are systems that offer use of shared bicycles for short, one-way trips between docking stations at various locations throughout urban areas. Use of bike-shares has drastically increased in the past 10 years. (1) The benefits of bike-sharing include emission reductions, increased physical activity, reduced traffic congestion, and ease of travel between public transit stations, to name a few. (1)

In summer of 2016, Vancouver, British Columbia launched its first bike-share program, Mobi. (2) The initial launch on July 19, 2016 offered 250+ bikes at 23 stations. When the system is fully rolled out there will be 1500 bikes at 150 stations around Downtown Vancouver. As of March 10, 2017 105 stations were operational. (2)

Bike-share programs have been incredibly successful around the world and Mobi is anticipating similar success. However, they face a unique challenge in that the province of British Columbia requires and legislates the use of a bicycle safety helmet when riding a bicycle. (3) To overcome the possibility of low ridership if users have to bring their own helmets, Mobi provides a helmet free of charge with each bike. A helmet is attached to each bike on the cable lock, which is released when the bike is rented, and is to be returned to that position after use. (2)

While this is a convenient, cost saving solution for users, it has brought up concern that shared helmets may be, as one reddit user put it, "like putting your head on a bike seat." (4) Commenters on this user's personal review of the bike-share service also expressed concern about the cleanliness of the helmets and the possibility of head lice transmission. (5,6) The issue also circulated in the news prior to Mobi's launch, but Mobi appears to have addressed it by assuring users of their daily cleaning regimen.

To date there has been little to no substantial research done on the transmission of disease through shared bicycle helmets, as the practice is relatively new to bike-sharing programs.

This study first attempted to determine whether there is the potential for the transmission of disease via shared bicycle helmets and whether the Mobi operations team is implementing adequate measures to mitigate or eliminate any risk associated with using the complimentary helmets. Secondly, a survey of Mobi users was conducted to determine whether or not users comfortable wearing the helmets provided, and if not, what their reasons are.

LITERATURE REVIEW

Disease transmission

Since so few bike-share programs provide helmets for free use, there is little information available on how risky the practice of sharing helmets might be. This review explored a variety of communicable diseases and conditions that are thought or known to be transmitted via fomites, especially those that affect the skin and hair. It determined whether or not there is the potential for transmission via bike helmets, keeping in mind that no studies have been found to prove or disprove transmission through helmets specifically.

Head Lice

Pediculosis capitis, commonly known as head lice, are perhaps what first comes to mind when considering sharing headwear. These wingless insects infect humans by attaching to hair and feeding on human blood. (7) It is well documented that they spread through direct contact from one head to another. (8) There is some disagreement between experts on whether they can be transmitted by fomites. (8) A report on head lice from the perspective of school nurses proposed that since lice cannot jump or fly, they are not easily contracted and cannot be transmitted via slick items like helmets. (7) In a study on lice movement, Canyon *et al.* found that hairs must be specifically oriented with one another for optimal transfer of lice, suggesting that fomite transfer is unlikely. (9) However, there is some evidence to the contrary. Both male and female adult lice have the ability to walk quite rapidly and may be triggered to do so in response to agitation of hair. (10,8) Lice can

also be transferred passively to fabric and survive for up to 3 days away from a human host; nits can live for up to 10 days. (8) One female louse is enough to infect a new host and start a new population. (8) This would seem to be the infection of most concern when it comes to sharing helmets. However, since lice only survive for a short time away from a host, it is unlikely that they would be transmitted via a helmet, unless it was worn shortly after wear by a person with an active infection. (11)

Bed Bugs

Bed bugs have slim, flat bodies that allow them to hide in tiny spaces. They are frequently spread by travelers on bedding, clothing, or luggage. (12) It would be possible for a bed bug to get into and hide in the liner of a bike helmet, even if it's not being worn, if, for example, it was being stored in the basket with a backpack or purse that had been in an infested building.

Scabies

Scabies is a skin disease caused by *Sarcoptes scabei* mites. The mites burrow under the skin of an infected person, causing an allergic reaction that manifests as intense itching and excoriated patches of skin in the area of infection. Mites are typically passed between household members through prolonged contact (such as hand holding, sexual contact or sharing a bed); brief contact like hand shaking will not allow transmission. *S. scabei* can only survive 1-2 days once detached from a host. (12,13) Classic scabies is not known to be transmitted through fomites; however, theoretically this could be enough time, if shed into a bicycle helmet during a 30-60 minute ride (the maximum allowed depending on Mobi membership plan), for a mite to attach to a new host. It would be more of a concern in the case of hyperinfection, where the host sheds many mites during contact. (2,14)

Scalp ringworm

Tinea capitis, or scalp ringworm, is a dermatophyte fungal infection of the scalp, causing scaling of the scalp and hair loss. It typically only affects children under age 12, with the peak age at 3-7, and is not commonly seen in adults. (15) Mobi requires users to be at least 19 year of age, or 16 with parental permission, to join the program so transmission of a pediatric infection should not be a concern (2). One case study of two elderly women, who contracted *Tinea capitis* from the same hairdresser, suggested that elderly people are slightly more susceptible than adults. (16) However, since the average age of bike-share users is fairly young (skewed toward 18-24 range) this disease does not pose a significant risk. (1)

Staphylococcus aureus skin infections

<u>Impetigo</u>

Impetigo is a highly contagious skin infection caused by *Staphylococci* and, less frequently, *Streptococci* bacteria or a combination of both. Clinical signs include superficial blisters, which rupture, leaving crusted scabs, most commonly on the legs and face. Fluids from the scabs are highly infectious through skin contact. Impetigo is most common in children but can be seen in adults. (17) A 2014 study by Gerhardts *et al*. explored the transfer pathway of *S. aureus* in sweat, blood and pus from skin to fabric to skin. They found that it remained viable on several different fabrics for at least 4 hours, thus concluding that fomite transmission was possible via fabric. (17) While none of the fabrics tested were identical to the interior of a bike helmet, these results were indicative of the infectiousness of *S. aureus* and its potential to be transmitted via a bike helmet.

<u>MRSA/CAMRSA</u>

Methicillin-Resistant *Staphylococcus aureus* is traditionally a nosocomial infection. However, Community-Aquired Methicillin-Resistant *S. aureus* (CAMRSA) is an emerging disease, for which fomite transmission has been documented. (18,19) In a 2009 study by Newsome *et al.* studying the use of disinfectants on shared school football equipment, helmets were swabbed for *S. aureus* before disinfectant application. (20) Colony forming unit counts on 14 helmets ranged from 20-100, with one too numerous to count (TNTC). Gerdharts *et al.*'s study indicated that as few as 4 CFUs of *S. aureus* would pose a high risk of infection. (17) Since football is a high exertion sport, heavy sweating in a football helmet is more likely than in a bicycle helmet, but it is worth noting that this study found shared equipment, including helmets, a high risk for transmitting CAMRSA. (20)

Infection control measures

Mobi states on its website that used helmets are thoroughly cleaned and inspected by the Mobi staff before distribution. Prior to launching, Vancouver news outlets reached out to Mobi to clarify what was meant by that statement. Roundhouse Radio published the following statement from Mobi General Manager, Mia Kohout:

"We will be doing regular checks throughout the day and night, visiting stations, checking bikes, checking helmets, cleaning helmets, making sure tires are all pumped up, so this will be part of our regular operations." (21)

In a CTV News viewer question segment, Ross McLaughlin reported that helmet liners are provided at all bike stations with information signs, helmets are sprayed with a disinfectant every day when the operations crew comes by to tune up the bikes, and some helmets are replaced or taken back to the operations centre for deeper cleaning. (22) Personal observation confirmed the presence of helmet liners at four of twelve observed docking stations. The other eight stations did not feature the helmet liner dispenser. The liners are made of a thin, papery fabric, similar to single use shoe covers and stretch over the head like a hair net. (personal observation)

Mobi customer service representatives also stated, via email that helmets are cleaned daily by operations staff using a helmet "refreshing" spray of water containing one cap of 99% isopropyl alcohol, one cap of vinegar and 5 drops of tea tree oil (23,11). The effectiveness of both vinegar and tea tree oil have been studied in household and environmental settings, and evidence suggests that both have some degree of antimicrobial action against fungi, viruses and vegetative stage bacteria. (24-27) Alcohol is also known to have strong germicidal properties at a concentration of 60-90% in water. (28) However, according to the BCCDC Infection Control Practitioner the amounts of these ingredients in the helmet spray are unlikely to have any cleaning or sanitizing effect on the helmets. (11) No evidence was found to support use of this specific mixture for disinfection, or the use of any of its components as an insecticide. In addition, studies have only demonstrated effects of such mixtures on hard surfaces; the interior of the helmets provided by Mobi is soft foam covered with a thin, felt-like fabric (personal observation).

Mobi also stated that helmets are periodically pulled from circulation to undergo a deep cleaning regimen, which includes submerging the helmets in a bleach and water solution, then a biodegradable soap solution and then a clean water rinse, in that order. They are then placed in a wire rack for drying. (11) A detailed Standard Operating Procedure (SOP) was provided to the BCCDC for comment on its efficacy and several concerns were brought up. Firstly, the SOP indicated that the order of cleaning steps was to sanitize, wash, then rinse. It is generally accepted that to effectively clean and sanitize, the order should be to wash, rinse, then sanitize. Secondly, the concentration of bleach in the sanitizing solution was too low and should be calculated to be 100ppm. Thirdly, the helmets require a longer contact time to achieve effective sanitization. Finally, it was not stated in the plan how frequently each helmet is cleaned. (11)

Mobi is currently working on updating the helmet cleaning SOP to reflect the suggestions from BCCDC, which will improve the efficacy of their cleaning regimen. The cleaning and sanitizing process has been corrected, and the company is working on determining an appropriate frequency for deep cleaning. (29)

Other bike share programs

Bike-share programs requiring helmet use were found in four other cities. CityCycle and Melbourne Bike Share (MBS) are located, respectively, in Brisbane, and Melbourne, Australia, where helmet use is required by law. MBS supplies courtesy helmets, which are attached to some, but not all bikes, and riders are able to purchase helmets for $5.00 from kiosks located up to 300 m from each bike station. (30) CityCycle does not provide helmets. Users are encouraged to use their own and can purchase one at the time of registration to the program. (31) Hubway, the bike-share program in Boston, Massachusetts requires helmet use as a company policy, but does not provide helmets. (32) The program most similar to Mobi was Pronto, located in Seattle, Washington, where helmet use is also compulsory. They provided

complimentary helmets, which were dispensed in a plastic wrapper from vending machines located at each docking station. The helmet and wrapper were to be placed in the return bin after use to be cleaned, re-wrapped and redistributed to the vending machines. (33) Pronto has since shut down and has stopped service as of March 31, 2017. The company that runs Pronto has not confirmed the reason for its failure, but CityLab web magazine sited several contributing factors including low ridership, and delays to expansion of the system; helmet requirement was not implicated as a major factor. (34)

It is clear that in locations where helmet use is required, supplying free helmets is a necessity to ensure high ridership, as studies have shown in Australia. (35,36)

Strengths & limitations of literature review

This literature review was limited by the fact that the helmet-sharing system that Mobi uses is the first of its kind and it is still in its early stages of use. There has been little to no research on the risks of a bike helmet-sharing scheme and no documented issues or outbreaks associated with helmet-sharing specifically. There is, however, an abundance of academic research on communicable skin and hair diseases, which provided ample information to establish the likelihood of disease transmission via bike helmets and similar items.

Conclusion

This review concluded that there may be risks involved in helmet-share that require further exploration. Sharing of bicycle helmets may facilitate transmission of communicable diseases including, head lice, bed bugs, scabies, and *Staphylococcus aureus* skin infections, however the risk is presumed to be low. This should not be considered an exhaustive list, nor should it be deemed definitive proof that these diseases are transmitted via shared helmets; rather this review has applied evidence, found in literature, of disease transmission via fomites, which have some similarity to a bicycle helmet.

Mobi states that they have committed to a cleaning regimen, which involves cleaning of helmets throughout the day as well as periodic deep cleaning. The efficacy of the current regimen is unknown, but the company is working to improve it.

There are currently no bike-share programs that use the same helmet system as Mobi to reference as a comparison and Mobi has only been operational for a few months. Any risks or perceived risks to the public associated with helmet-sharing are not yet established.

MATERIALS & METHODS

Materials

The survey was created using SurveyMonkey. (37) In-person surveys were conducted on an iPad, rented from the BCIT library, using internet connection from a mobile phone. Snack-sized chocolate bars were offered to participants of the in-person survey. Printouts of a link to the survey were distributed to Mobi users (both those who participated and who declined). The survey was distributed online using social media sites Facebook, Twitter, and Reddit. (38-40)Data organization and descriptive statistics were performed using Microsoft Excel. (41) Inferential statistics were performed using NCSS. (42)

Methods

Choosing survey locations and times

A list of bike-docking stations was compiled using the map provided on the Mobi website (Figure 1). (2) Each station was assigned a number. A random number generator in Microsoft Excel was used to choose the first station. (41) For the remainder of the surveys conducted, stations were chosen based on where the researcher would likely encounter the most cyclists (i.e. stations on protected bicycle paths, in close proximity to businesses and Skytrain stations). Surveys were conducted during periods of high traffic, during evening commutes: 3pm – 6pm (45), as well as other time slots throughout the day as time permitted (i.e. on weekends). Research was conducted in fair weather as much as possible, and was postponed during moderate to heavy rain and snow. Cold weather and snow may have contributed to low ridership, which resulted in fewer riders available for interviews. Dates,

times and locations were recorded.

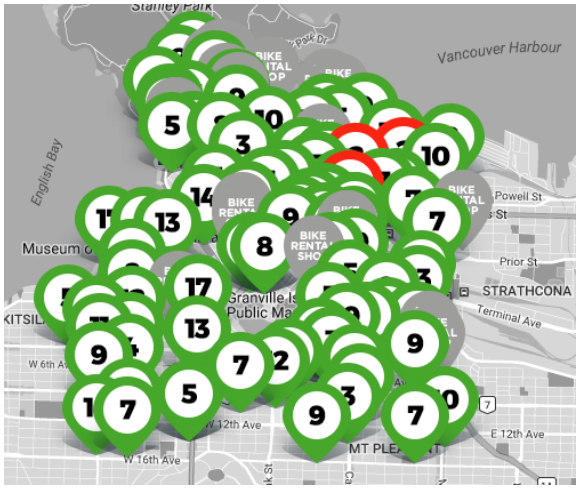

Figure 1. Clip of Mobi "Find a Bike" Map (2)

Administering survey in person

The researcher observed the docking stations. When someone was seen either returning a bicycle or taking one out, the researcher approached them and invited them to participate in the study using a standardized script.

If the user agreed to participate, they were handed the iPad to take the survey, which included a short cover letter. They were required to confirm that they gave consent to participate in the study by checking "yes" on the first question of the survey. The user was given several minutes to complete the survey. If the user did not wish to participate in the survey in person, the researcher provided a link to the survey to complete at a later time. Upon completion, the researcher thanked the participant for their time, allowed them to take a piece of candy and provided them with the link to the survey to share with fellow Mobi users.

Administering survey online

Sampling was non-random; it was a combination of purposive sampling, where only members of a specific population were included in the survey (Mobi users) and snowballing, where the survey is distributed to a group, and members of that group distribute it within their networks. (46)

a. **Facebook**: the researcher shared a post on Facebook, which included a link to the survey and requested that classmates and friends distribute it to their friend networks.
b. **Twitter**: the survey was tweeted several times using "@" mentions directed to people and organizations that frequently interacted with Mobi on Twitter including: @WeAreHub, @modacitylife, @BrentToderian, @cityofvancouver, @greenestcity, @VIAwesome, @ParkBoard, @CBCOnTheCoast. Several of these Twitter users "retweeted" the survey.
c. **Reddit**: the survey was posted on reddit on the /r/vancouvercycling page. The researcher's classmates "upvoted" the post so it would remain near the top of the page.
d. The researcher placed printouts of the survey link in the handlebars of several Mobi bicycles for users to take when they took out a bicycle.

Inclusion/Exclusion Criteria

Any person who was observed by the researcher using a Mobi Bike was eligible to participate in the in-person self-administered survey. This includes regular and occasional users. Participants completing the online survey self-identified as Mobi users.

Ethical Considerations

This study was reviewed and approved by the instructor for ENVH 8400 Research Methods, as per the BCIT Research Ethics for Human Participants Policy. (47) The risk for participating in this study was no more than normal risks of day-to-day living. Participants were required to read the cover letter to ensure they were fully informed about the aims of the study and give informed consent to participate in the study. Participants were made aware that they were free to withdraw consent at any time during their participation without penalty. (46) Participants were assured that their answers would be kept strictly confidential. No names, personal information or other identifiers were collected in the this study unless participants chose to provide their email address for follow-up.

RESULTS AND STATISTICAL ANALYSIS

The survey data collected in this study was nominal. Data was downloaded from SurveyMonkey into Microsoft Excel, where

descriptive statistics were completed. Data was organized in excel and copied into NCSS to perform Chi-square tests. The following diagrams are descriptive statistics of the 47 responses to the this survey.

The majority of surveys were completed online. Only 8 were completed in-person. The Facebook post collected 5 responses. The remaining 34 responses ("Other online" in figure 2) were obtained by distributing the survey link on Twitter, Reddit, and on paper to riders when conducting in-person surveys.

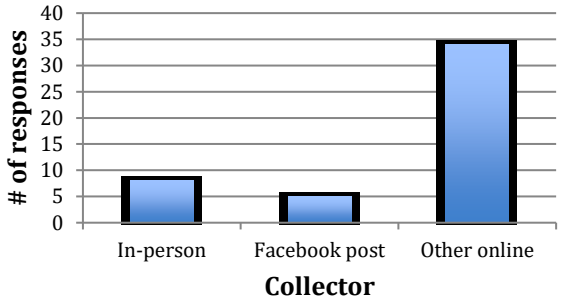

Figure 2. Methods of survey collection

The majority of respondents were under 56 yrs of age (figure 3) and many respondents were only occasional users, even during the summer (figure 4). As seen in figure 5, 81% of respondents were at least somewhat concerned with the cleanliness of the helmets provided by Mobi and 40% of respondents would be more likely to use Mobi helmets if they were cleaned to their satisfaction (figure 8).

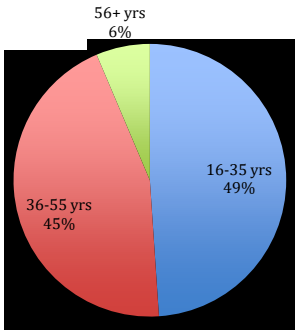

Figure 3. Age of respondents

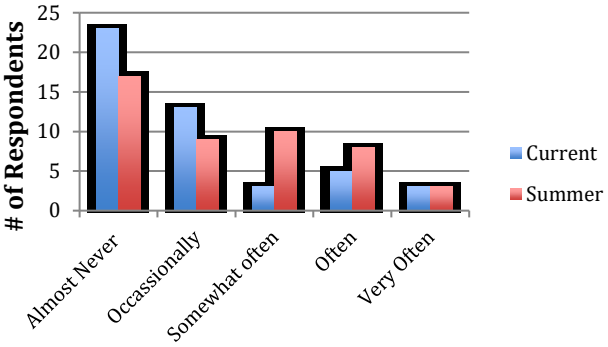

Figure 4. Comparison of how often respondents use Mobi bikes currently (Jan-Feb 2017) and how often they use them in warmer weather

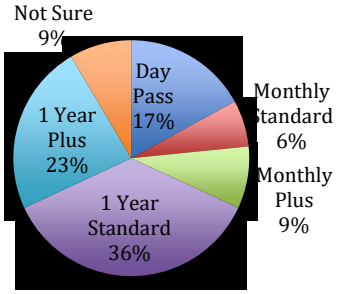

Figure 5. Proportion of respondents with each type of Mobi pass.

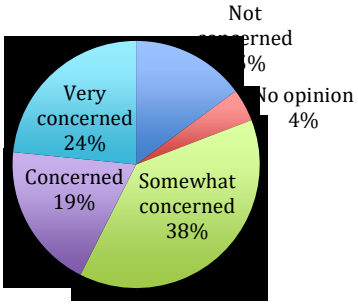

Figure 6. How concerned respondents were with the cleanliness of Mobi helmets.

When asked what they feel is an adequate way of cleaning the helmets provided by Mobi (figure 8), 28% of respondents chose "providing helmet liners", which Mobi does at several, but not all bicycle docking stations. "Other" was chosen by 26% of respondents; suggestions included having the helmets cleaned regularly by staff, as well as several responses stating that helmet use should not be mandatory. Another suggestion was to have some method

such as waterproof bags to protect the helmets from rain and snow.

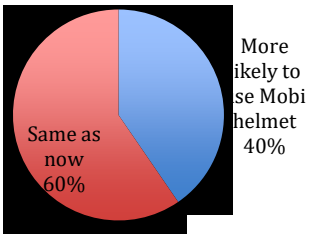

Figure 7. Responses to the question of if Mobi users would be more likely to use Mobi helmets if they were cleaned to their satisfaction.

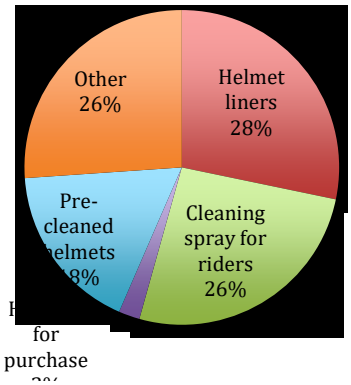

Figure 8. Responses to the question of what users feel is an adequate way of cleaning the helmets provided by Mobi.

Of the ten respondents who said they "Never" or "Only some of the time" wear a helmet when riding their personal bikes, seven said they were not concerned about legality, five were not concerned about personal safety, 4 found helmets uncomfortable, and three did not like how helmets look (figure 9). Of the 25 respondents who chose "Never", "Only some of the time" or "I wear my own helmet" when asked if they use the helmets provided when using Mobi bikes, 14 were not concerned about legality, nine were not concerned about personal safety, one found it difficult to see when wearing a helmet, nine found helmets uncomfortable, and 20 were concerned with the cleanliness of Mobi helmets (figure 10). As seen in figures 9 and 10, 15 respondents chose "Other" as the reason to not wear a helmet both on personal bikes and Mobi bikes. Comments indicated that many riders shared the opinion that helmets are not necessary when cycling on protected urban cycling paths, and that helmets should not be required by law.

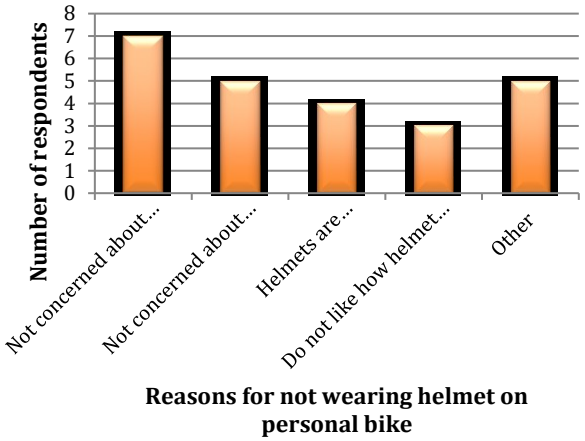

Figure 9. Reasons for not wearing a helmet on personal bike (includes respondents who chose "Never" or "Only some of the time")

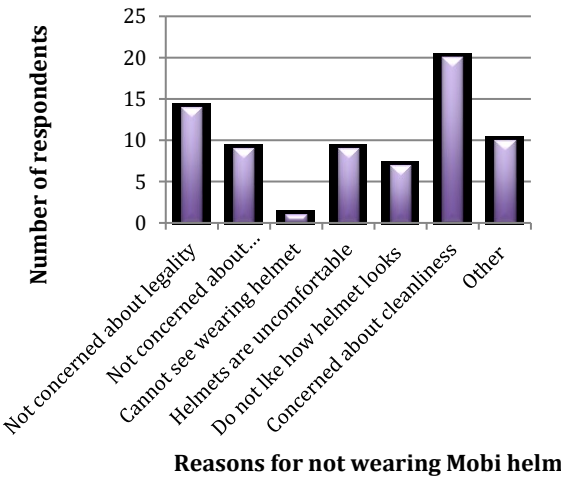

Figure 10. Reasons for not wearing helmet provided when using Mobi bikes (includes respondents who chose "Never", "Only some of the time" or "I wear my own helmet")

Inferential Statistics

1. Association between helmet use on personal bikes and helmet use on Mobi bikes

There was an association between helmet use on personal bikes and helmet use on Mobi bikes ($p=0.00029$). Those who always wore a helmet on their person al bike were more likely to always wear a helmet when using Mobi bikes. Those who never wore a helmet on their

personal bike were more likely to never wear a helmet on Mobi bikes.

2. Association between Mobi helmet use and level of concern for how clean Mobi helmets are

There was no association found between these two variables (p=0.54995).

3. Association between most important factor and use of Mobi helmets

There was an association found between likelihood of using Mobi helmets and which factor was rated most important to the user (of aesthetics, cleanliness, comfort/fit, legal requirement, and safety) (p=0.02038). Those who chose safety as the most important factor contributing to their decision to wear the helmet provided by Mobi were more likely to always wear the helmet. Those who chose cleanliness as the most important factor were more likely to never wear the helmet.

Sources of error

There was the possibility for alpha error (the null hypothesis being incorrectly rejected) in the third chi-square test. If the alpha was decreased to 0.01, the association would not be statistically significant.

DISCUSSION

Three hypotheses regarding helmet use were tested in this study. Firstly, there was an association found between wearing a helmet on a personal bike and wearing a helmet when riding a Mobi bike. People who always wore a helmet on their personal bike were more likely to always wear a helmet when riding a Mobi bike. Secondly, there was no association between how concerned users were with the cleanliness of the Mobi helmets and how likely they were to wear them. However, there was an association between the factor that was rated most important to users in the decision to wear or not wear the Mobi helmet (out of the possible choices of aesthetics, comfort/fit, legal requirement, safety, and cleanliness) and how likely they were to use the Mobi helmet. Those who expressed that cleanliness was the most important to them were the most likely to never wear the Mobi helmet. Those who chose safety as most important were most likely to always wear the Mobi helmet. This is consistent with what the researcher had predicted finding; however, a larger study with more participants may have acquired different results.

Several questions were also open for comments and the responses provided some insight into users' motivations for choosing to wear or not wear the helmet provided by Mobi. Four participants stated that they didn't always wear the helmets, especially in the winter, because they were wet from rain and snow. This was observed by the researcher as well. The helmets are not protected from the weather and would reasonably be soaked after a day of heavy rain. Of the 47 participants, 13 of them indicated that they didn't believe that helmets were necessary for various reasons. Several people expressed the opinion that cycling is a safe activity, especially with proper cycling infrastructure including separated bike lanes. Others felt that it is important to normalize cycling without a helmet to encourage cycling to those who find the helmet requirement an obstruction to riding, and that requiring helmets gives the impression that cycling is dangerous and may discourage riding. There has been much research on this topic. Helmet use has been associated with reduced head injuries in several studies, and a US study stated that helmet legislation had quadrupled helmet use. (48,49) Others state that helmet legislation is most effective when combined with other safety initiatives including reduced speed limits and improvements in cycling infrastructure such as separated bike lanes. (50) In addition it was shown in a Boston study that improved cycling infrastructure both increases ridership and improves cyclist safety. This study concluded that increasing ridership could itself increase safety, as "there is safety in numbers"; there is an inverse relationship between an increase in number of cyclists and the likelihood of being struck by a motorist. (51)

Unfortunately, overcoming the helmet requirement that is legislated by the Province of British Columbia is not something that Mobi is able to do. They have chosen to accommodate the legal requirement by providing helmets so that every rider has the option to wear one.

Based on the aforementioned comments, there will still be riders who choose not to wear the helmet provided, despite any improvements made to the helmet cleaning procedure.

Other comments, although only expressed by individuals, provided interesting information. For example, one user who usually chose to wear the helmet provided was unable to at time she was surveyed as the bike she signed out was missing a helmet. All the other bikes at the station were visibly soiled and there were pigeons perched on and around most of the bikes. This issue was observed on at least three occasions by the researcher at the same station.

Figure 11. Pigeons perched on Mobi bike handlebars at Granville & Georgia bike station

Limitations

There were several limitations encountered when conducting this study. Firstly, the response rate was fairly low, as there were only 47 participants in this study. This was partly due to the seasonal variation in bike-share ridership. This study was conducted between January 21 and February 17, during which there was considerable snow and rainfall and cool temperatures in Vancouver. (52) The inclement weather was expected to affect response rate, and it appears that it did. However, the study would have to be repeated in the summer to determine if more favourable weather would increase participation. Another issue was the fact that with only one researcher conducting the survey with limited time, it was not possible to reach all the docking stations. Important and frequently used stations may have been missed. It was also difficult to predict which station(s) to conduct surveys at to collect the most responses. Although Mobi was recording hundreds of trips per day at the time of this survey, there were 105 stations and it was impossible to know where the most riders would be at any given time. Prior observation of the docking stations would have been useful to determine the most popular stations and at what time different stations were more likely to be used. More results may also have been collected if there had been multiple researchers conducting in-person surveys.

Another reason for low participation was the limited inclusion criteria. The survey was designed to be taken only by Mobi users. Had the survey been open to the general public, there may have been more participants. However, there would have been a trade-off with the quality of the data. People who use Mobi bikes, even occasionally, likely have more valuable opinions on the service than those who have never used it.

Also, although the survey was fairly short and took only five minutes to conduct, many Mobi users didn't have time to spare as they were commuting. This issue was partly mitigated by distributing a link to the survey to those who declined to take the in-person survey. Use of social media was also limited, as the researcher's social network didn't reach many Mobi users.

Recommendations

The results of this study will be provided to Mobi. The company is currently in the process of updating their Standard Operating Procedure (SOP) for cleaning the helmets based on the recommendations given to them by the BCCDC's Infection Control Practitioner and Environmental Health Specialist, as well as the author of this paper.

Mobi should consider posting their helmet cleaning procedures on their public website. Some users may feel more comfortable using the helmets provided if they were aware of how they were cleaned. A suggestion to Mobi was also made that they should utilize their riders as a resource to report helmets that require cleaning.

Future research

- Many people are not aware of how the helmets are cleaned. If this information was shared, a follow-up study could determine if

people would be more likely to wear helmets once they're aware of how they're cleaned.
- Mobi is updating their cleaning procedures. A researcher could follow-up to see if improved cleanliness has an impact on helmet use.
- This study excluded people who did not use Mobi. Some of these people may have chosen not to use Mobi because of the helmet issue; their opinions may be important. Future research could open a similar survey to the general public.
- Risk assessment and comparison between the possibility of contracting an illness from shared helmets and the potential for head injury without a bicycle helmet (public health trade-off)
- Microbiological testing of disease transmission via helmets, including developing an acceptable method to spot clean them at the docking stations
- Study of how the helmets have stood up to Vancouver's wet winters

Conclusions

This study determined that there was an association between helmet use on personal bikes and helmet use on Mobi bikes (using helmet provided by Mobi). There was also an association between which factor the rider found most important when choosing to wear the Mobi helmet (out of cleanliness, aesthetics, comfort/fit, safety, and legality), and their likelihood of wearing the Mobi helmet. There was no association found between the level of concern for cleanliness specifically and likelihood of wearing the Mobi helmet. Statistical results and comments indicated that the majority of participants were at least somewhat concerned with cleanliness of the helmets but also that many participants chose not to wear the helmets because of their personal opinion that helmets should not be a requirement for cycling. The significance that the researcher hoped to achieve in this study was to ensure that the helmets being provided are clean and will not facilitate disease transmission. Though the efficacy of the helmet-cleaning regimen has yet to be documented, Mobi is already in the process of making improvements to the procedure to ensure the safety of their riders.

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REFERENCES

1. Fishman E, Washington S, Haworth N. Bike Share: A Synthesis of the Literature. Transport Reviews [Internet]. 2013 [cited 2016 Oct 20]; 33(2): 148-165. Available from http://tinyurl.com/mk8jhj6

2. Mobi. Mobi [Internet]. Vancouver, BC. 2016 [cited 2016 Oct 19]. Available from: https://www.mobibikes.ca/

3. BC Motor Vehicle Act [RSBC 1996] Chapter 318. Sect. 184 (1). 2016 Oct 12 [cited Oct 22]. Available from: http://www.bclaws.ca/civix/document/id/complete/statreg/96318_00

4. dbarefoot. reddit/r/Vancouver [blog on the Internet]. Vancouver: reddit. My review of Mobi, Vancouver's bike-share service; 2016 Aug [cited 2016 Oct 20]; [796 words]. Available from: https://www.reddit.com/r/vancouver/comments/4wnurx/my_review_of_mobi_vancouvers_bikeshare_service/

5. pfak. Comments on: My review of Mobi, Vancouver's bike-share service. 2016 Aug [cited 2016 Oct 20]. In: dbarefoot. reddit/r/Vancouver [blog on the Internet]. Vancouver: reddit. 2016 Aug. [796 words]. Available from: https://www.reddit.com/r/vancouver/comments/4wnurx/my_review_of_mobi_vancouvers_bikeshare_service/

6. SLBMLQFBSNC. Comments on: My review of Mobi, Vancouver's bike-share service. 2016 Aug [cited 2016 Oct 20]. In: dbarefoot. reddit/r/Vancouver [blog on the Internet]. Vancouver: reddit. 2016 Aug. [796 words]. Available from:

https://www.reddit.com/r/vancouver/comments/4wnurx/my_review_of_mobi_vancouvers_bikeshare_service/

7. Pontius DJ. Demistifying head lice. Pediatric Nursing [Internet]. 2014 Oct [cited 2016 Oct 20]; 40(5): 226-235. Available from: http://tinyurl.com/lmov6y6

8. Burkhart CN. Fomite transmission with head lice: a continuing controversy. Lancet. [Internet] 2003 [cited 2016 Oct 20];361:99–100. Available from: http://tinyurl.com/mdv4pmq

9. Canyon D V., Speare R, Muller R. Spatial and Kinetic Factors for the Transfer of Head Lice (*Pediculus capitis*) Between Hairs. J Invest Dermatol [Internet]. 2002 Sep [cited 2016 Oct 20];119(3):629–31. Available from: http://linkinghub.elsevier.com/retrieve/pii/S0022202X15417713

10. Takano-Lee M, Edman JD, Mullens BA, Clark JM. Transmission potential of the human head louse, *Pediculus capitis* (*Anoplura: Pediculidae*). Int J Dermatol [Internet]. 2005 Oct [cited 2016 Oct 19];44(10):811–6. Available from: http://doi.wiley.com/10.1111/j.1365-4632.2005.02418.x

11. McIntyre L. Mobi bike cleaning regimen for helmets [Internet]. Message to: Ali Moore. 2017 Jan 25 [cited 2017 Mar 11]. [11 paragraphs].

12. CDC Centers for Disease Control and Prevention [Internet]. Atlanta, GA: US Dept of Health & Human Services. Bed Bugs FAQs; 2013 Jan 10 [cited 2016 Oct 23]. Available from: https://www.cdc.gov/parasites/bedbugs/faqs.html

13. Gould D. Prevention , control and treatment of scabies. Nurs Stand [Internet]. 2010 [cited 2016 Oct 20];25(9):42–6. Available from: http://tinyurl.com/ka5v3ll

14. CDC Centers for Disease Control and Prevention [Internet]. Atlanta, GA: US Dept. of Health & Human Services. Parasites – Scabies; 2010 Nov 2 [cited 2016 Oct 20]. Available from: https://www.cdc.gov/parasites/scabies/

15. Patel GA, Schwartz RA. *Tinea capitis*: still an unsolved problem? Mycoses [Internet]. 2011 May [cited 2016 Oct 19]; 54(3):183–8. Available from: http://doi.wiley.com/10.1111/j.1439-0507.2009.01819.x

16. Takwale A, Agarwal S, Holmes SC, Berth-Jones J. *Tinea capitis* in two elderly women: transmission at the hairdresser. Br J Dermatol [Internet]. 2001 Apr [cited 2016 Oct 19]; 144(4):898–900. Available from: http://doi.wiley.com/10.1046/j.1365-2133.2001.04154.x

17. Gerhardts A, Henze SV, Bockmühl D, Höfer D. Fabric-skin models to assess infection transfer for impetigo contagiosa in a kindergarten scenario. Eur J Clin Microbiol Infect Dis [Internet]. 2015 Jun 10 [cited 2016 Oct 19];34(6):1153–60. Available from: http://link.springer.com/10.1007/s10096-015-2336-7

18. Cohen PR. Community-acquired methicillin-resistant *Staphylococcus aureus* skin infections: a review of epidemiology, clinical features, management, and prevention. Int J Dermatol [Internet]. 2007 Jan [cited 2016 Oct 19];46(1):1–11. Available from: http://doi.wiley.com/10.1111/j.1365-4632.2007.03215.x

19. Mahoney D. MRSA and staph in schools. Professional Safety [Internet] 2015 Mar [cited 2016 Oct 20]; 60(3): 44-46. Available from: http://tinyurl.com/lo2ykdu

20. Newsome AL, DuBois JD, Tenney JD. Disinfection of football protective equipment using chlorine dioxide produced by the ICA TriNova system. BMC Public Health [Internet]. 2009 Dec 8 [cited 2016 Oct 20]; 9(1):326. Available from: http://bmcpublichealth.biomedcentral.com/articles/10.1186/1471-2458-9-326

21. Landert K. Vancouver launches new bike share program. RoundhouseRadio 98.3 Vancouver [Internet]. 2016[cited Oct 20]; Available from:

http://www.roundhouseradio.com/news/2016/07/20/vancouver-launches-new-bike-share-program

22. McLaughlin R. Viewer inbox: Mobi bike helmet cleaning [Internet]. CTV News Vancouver; 2016 [cited 2016 Oct 20]. Available from: http://bc.ctvnews.ca/viewer-inbox-mobi-helmet-cleaning-holiday-pay-samsung-washers-1.3095348

23. Mobi Customer Service. Bikes [Internet]. Message to: Ali Moore. 2016 Oct 22 [cited 2016 Oct 22]. [1 paragraph].

24. Peeiulyte D. Effect of tea tree essential oil on microorganisms 2. Evaluation of fungal ...:. Biologija [Internet]. 2015 [cited 2016 Oct 23]; 2:21–8. Available from: http://tinyurl.com/kao9zdh

25. Goodyear N, Brouillette N, Tenaglia K, Gore R, Marshall J. The effectiveness of three home products in cleaning and disinfection of *Staphylococcus aureus* and Escherichia coli on home environmental surfaces. J Appl Microbiol [Internet]. 2015 Nov [cited 2016 Oct 23];119(5):1245–52. Available from: http://doi.wiley.com/10.1111/jam.12935

26. Usachev EV, Pyankov OV, Usacheva OV, Agranovski IE. Antiviral activity of tea tree and eucalyptus oil aerosol and vapour. J Aerosol Sci [Internet]. 2013 May [cited 2016 Oct 23]; 59:22–30. Available from: http://linkinghub.elsevier.com/retrieve/pii/S0021850213000086

27. Jafari AA, Tafti AF, Lofti-Kamran HL, Zahraeii A, Kazemi A. Vinegar as a Removing Agent of *Candida albicans* from Acrylic Resin Plates. Jundishapur J Microbiol [Internet]. 2012 [cited 2016 Oct 23]; 5(2):338-92. Available from EBSCOhost: http://tinyurl.com/lqqmcjh

28. CDC Centers for Disease Control and Prevention [Internet]. Atlanta, GA: US Dept of Health & Human Services. Guideline for Disinfection and Sterilization in Healthcare Facilities, 2008; 2009 [cited 2016 Oct 23]. Available from: https://www.cdc.gov/hicpac/Disinfection_Sterilization/acknowledg.html

29. Mecar M. Mobi bike cleaning regimen for helmets [Internet]. Message to: Ali Moore. 2017 Mar 10 [cited 2017 Mar 11]. [1 paragraph].

30. Melbourne Bike Share. Melbourne Bike Share [Internet] Melbourne, Australia. 2016 [cited 2016 Oct 22]. Available from: http://www.melbournebikeshare.com.au/

31. CityCycle. CityCycle [Internet] Brisbane, Australia. 2016 [cited 2016 Oct 22]. Available from: http://www.citycycle.com.au/

32. Hubway. Hubway [Internet]. Boston, Massachusetts: Motivate International, Inc. [2016; cited 2016 Oct 21]. Available from: https://www.thehubway.com/

33. Pronto. Pronto Cycle Share [Internet]. 2016 [cited 2016 Oct 21]. Available from: https://www.prontocycleshare.com/

34. Small A. CityLab [Internet]. Washington, DC. The Atlantic. The Four Horsemen of the Bike Share Apocalypse; 2017 Jan 31 [cited 2017 Mar 10] Available from: http://www.citylab.com/commute/2017/01/seattle-bike-share-pronto-goes-under/513575/

35. Ahillen M, Mateo-Babiano D, Corcoran J. Dynamics of bike sharing in Washington, DC and Brisbane, Australia: Implications for policy and planning. Int J Sustain Transp [Internet]. 2016[cited 2016 Oct 20];10(5):441–54. Available from: http://www.tandfonline.com/doi/full/10.1080/15568318.2014.966933

36. Fishman E, Washington S, Haworth N, Watson A. Factors influencing bike share membership : An analysis of Melbourne and Brisbane. Transportation Research Part A: Policy & Practice. 2015 [cited 2016 Oct 20];71:17–30. Available from http://tinyurl.com/n2wcr87

37. SurveyMonkey [Internet]. [cited 19 Feb 2016]. Available from https://www.surveymonkey.com/r/8BQFSY3

38. Facebook [Internet]. [cited 19 Feb 2016]. Available from https://www.facebook.com/

39. Twitter [Internet]. [cited 18 Feb 2017]. Available from https://twitter.com/

40. Reddit [Internet]. [cited 18 Feb 2017]. Available from https://www.reddit.com/r/vancouvercycling/

41. Microsoft Excel. Microsoft; 2008

42. NCSS 11 Statistical Software (2016). NCSS, LLC. Kaysville, Utah, USA. Available from: ncss.com/software/ncss

43. Heacock H. Research Design & Data Collection [unpublished lecture notes]. BCIT; [notes provided in lecture 26 Sep 2016]

44. Mobi Bikes [Internet]. [cited 18 Feb 2017]. Available from https://www.mobibikes.ca/

45. Lynch D. About Travel [Internet]. Vancouver: Getting around Vancouver. [27 Jan 2016] [cited 19 Feb 2017]. Available from: http://vancouver.about.com/od/gettingaround/tp/Getting-Around-Vancouver-Bc.htm

46. Kelley K, Clark B, Brown V, Sitzia J. Good practice in the conduct and reporting of survey research. Int J Qual Heal Care. 2003;15(3):261–6.

47. BCIT [Internet]. Burnaby, BC. 04 May 2011 Research Ethics for Human Participants Policy [cited 20 Nov 2016]. Available from: http://www.bcit.ca/files/pdf/policies/6500.pdf

48. Sethi M, Heidenberg J, Wall SP, Ayoung-Chee P, Slaughter D, Levine DA, Jacko S, Wilson C, Marshall F, Pachter HL, Frangos SG. Bicycle helmets are highly protective against traumatic brain injury within a dense urban setting. Injury [Internet] 2015 Dec [cited 2017 Mar 11] 46(12):2483-2490. Available from http://tinyurl.com/k3r69xe

49. Hagel BE, Yanchar NL. Bicycle helmet in Canada: The need for legislation to reduce the risk of head injury. Paediatrics & Child Health. [Internet]. 2013 Nov [cited 2017 Mar 11] 18(9): 1205-7088. Available from: http://tinyurl.com/khuustl

50. Ohlin M, Strandroth J, Tingvall C. The combined effects of vehicle frontal design, speed reduction, autonomous emergency braking and helmet use in reducing real life bicycle injuries. Safety Science [Internet]. 2016 May 30 [cited 2017 Mar 11]92: 338-344. Available from http://tinyurl.com/n6b52gg

51. Pedroso FE, Angriman F, Bellows AL, Taylor K. Bicycle use and cyclist safety following Boston's bicycle infrastructure expansion, 2009-2012. Am J Public Health [Internet] 2016 Dec [cited 2017 Mar 12] 106:2171-2177. Available from http://tinyurl.com/l7dpbw2

52. The Weather Network [Internet]. 2017 [cited Mar 11]. Available from: https://www.theweathernetwork.com/weather/historical-weather/cabc0308