Childhood Injury Prevention through Community-Based Participatory Research
-A Multidimensional Approach in the Love & Safety Omura Study in Nagasaki, Japan –

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ABSTRACT

The purpose of this research is to create a multi-disciplinary society where community members, educators, engineers, manufacturers and policy makers work together for injury prevention, recognizing one another’s strengths. In this paper, we first discuss how the power of injury prevention is strengthened by employing a community-based participatory research (CBPR) approach. “Love & Safety Omura Study” is implemented in collaboration with medical institutions, the local school board, day-care centers and kindergartens, the police department and the fire department in Omura, Nagasaki, Japan as the first CBPR project on childhood injury. We collected data on traumatic injuries that occurred in Omura, Nagasaki, Japan and extracted 99 children’s injury cases. As a result of data analysis, the number one cause of injury was falls followed by bicycle-related injuries, car crashes, and collisions. For an educational purpose, we developed digital content based on the results. Based on injury frequency and severity, road traffic injury including bicycle-related injuries, burns, drowning, accidental ingestions, and falls were selected for the topics of digital content. We discuss how we designed digital content aimed at enhancing one's perception of susceptibility to and severity of injuries. Lastly, we proposed a framework for implementing knowledge circulation-oriented CBPR on real life problems.

Keywords: Childhood Injury Prevention, Multidimensional Approach, Community-based Participatory Research, Health Education, Animation, Action-oriented.

1. INTRODUCTION

Infectious diseases were once the greatest killer of people worldwide. However, thanks to advances in public health and medicine, deaths from these diseases have significantly decreased, making lifestyle-related chronic diseases the current major cause of death. Due to this shift, prevention is even more important than ever before, to avoid unnecessary deaths and disabilities. The same trend can be observed in child health. In Japan, the number one or two cause of death between the ages of 1 to 19 years are unintentional injuries[1] In fact, unintentional injuries are a major global health problem. In 2006, the World Health Organization released the ten-year plan of action on childhood injuries[2], followed by the first world report on child injury prevention in 2008[3], to highlight the importance of injury prevention.

In the field of injury prevention, the most remarkable paradigm shift is that injuries are now regarded as preventable and predictable events. Epidemiological analyses reveal the types of injury and the age groups of children at risk, while preventive measures and safety practices are being developed to lower the risk. It is estimated that as many as 90% of injuries are preventable by implementation of effective measures[4].

In the past two decades, the community-based participatory research (CBPR) approach has been increasingly recognized as being effective in addressing health disparities. CBPR is “a partnership approach to research that equitably involves community members, practitioners and academic researchers in all aspects of the process, enabling all partners to contribute their expertise and share responsibility and ownership”[5]. It is an action-oriented and community-driven research approach to understanding the root causes of a given health issue by
integrating knowledge and skills from the communities involved[5]. “Participatory” does not simply mean that community members physically participate in the research. In CBPR, participation of community members is achieved when, by the end of the research, community members have gained new knowledge and skills to solve their health problems. Participation for researchers means that they find solutions that are agreeable to the community members.

We conducted a community-based participatory research project, named the “Love & Safety Omura Study”, in collaboration with medical institutions, the local school board, day-care centers and kindergartens, the police department and the fire department in Omura, Nagasaki, Japan. The purpose of this research was to create a multi-disciplinary society where community members, educators, engineers, manufacturers and policy makers work together, recognizing one another’s strengths. In this paper, we first discuss how the power of injury prevention is strengthened by employing a CBPR approach. In addition, we consider injury prevention from a viewpoint of three dimensions: the societal dimension, the everyday life dimension, and the life elements dimension. Then, we discuss how we designed digital content aimed at enhancing one’s perception of susceptibility to and severity of injuries. At the end of this paper, we proposed the framework for a CBPR project on real life problem solving such as childhood injury.

2. CHILDHOOD INJURY PREVENTION THROUGH COMMUNITY-BASED PARTICIPATORY RESEARCH

Injury prevention involves control over specific phenomena in daily life. In the case of unintentional injuries, there are three categories of variables: variable A, which we want to control; variable B, which we can change; and variable C, which we cannot change but knowledge of which is important to explain injuries (Figure 1). Examples of each of the variables are as follows:

- Variable A: number of deaths, severity of injuries, number of drownings.
- Variable B: product design parameters, parental knowledge and behaviors.
- Variable C: age of children at risk, child behavior such as crawling, weather, time.

It is necessary to first identify these three categories of variables and to find a rule to describe the relationship between them (Injury control model). Then, researchers can discuss how to control variable A by manipulating variable B.

Figure 1: Injury control model

For injury prevention, there are three types of B variables, known as the 3 Es: Education, Engineering and Enforcement. The practice of each of these variables to control injuries is, however, associated with unique challenges. In terms of behavior change through education, the challenge is to inculcate these behavioral changes and to maintain newly learned behavioral skills. In addition, although people understand the risk of an injury, they are not likely to take preventive measures if doing so requires a huge effort. From an engineering perspective, many products are not designed and manufactured based on injury data. Even if the design of a product is changed to reduce the risk of an injury, safety will not be ensured unless people use the modified product correctly. Moreover, as the environment surrounding children keeps changing with the release of new products, injuries related to the products are bound to occur. Thus, manufacturers always need to develop new strategies to prevent injuries. Regarding enforcement, the introduction of new laws and regulations takes time, and all necessary preventive measures cannot be legislated.

In order to overcome these challenges, a collaborative and multidisciplinary approach is key to the development of effective injury prevention strategies. It is necessary to identify children’s physiological factors, such as sex and age, behavioral factors such as ability to roll over, crawl and ride a bike, and environmental factors such as the type of ground surface and products related to injuries to develop the injury control model. All identified factors are categorized into the 3 types of variables mentioned above. Then, the B variable, which when modified can produce the greatest reduction of injury risk, needs to be identified. Doctors, nurses, product designers, engineers, psychologists, public health professionals and other professionals from different disciplines must work together to develop the injury control model because each professional has different knowledge. When medical professionals come together, they tend to discuss children’s physiological factors, which are often characterized by variable C. Therefore, they will be unable to develop the model and find the B variable that can be altered for effective injury prevention. Likewise, product designers know how to change the design of a product, but they may not be as knowledgeable about the natural course of children’s behavioral development and the relationship between child-product interactions. Hence, they are unlikely to be able to completely ensure product safety by changing the product designs to suit children’s physiological development. Thus, the best way to achieve injury prevention is by integrating multidisciplinary expertise.

Effective injury prevention also requires collaboration not only of multidisciplinary professionals but also of nonprofessionals who should receive the full benefits of injury prevention. Nonprofessionals, including parents and children, play two critical roles in childhood injury prevention. The first is sharing their knowledge of what promotes or impedes their safe behaviors with researchers. Even though safe products are manufactured, an injury will not be prevented unless nonprofessionals use the products correctly. The second role of nonprofessional is to provide injury data. Researchers need data on who are at most risk, which products cause injuries, which child behaviors lead to injuries, or how injuries occur, in order to develop the injury control model. Without data, it would not even be possible to
recognize the fact that childhood injuries are an important health issue, let alone finding a solution for this problem.

Recently, the CBPR has evolved as a multidisciplinary approach to work with communities, and its approach is particularly effective in understanding complex injury phenomena and finding the most effective means of protecting children. The necessity of applying the CBPR approach to injury prevention is recognized from the standpoint of dimensions. Childhood injuries will not be prevented without simultaneously dealing with the three dimensions described in Figure 2. The societal dimension is the most macro level of all. Injuries are part of a phenomenon that is spread widely and thinly over this dimension. An accurate picture of injury patterns and trends is revealed when collecting injury data at a societal level. This dimension deals with variable A in the injury control model.

Once the leading causes of death and common types of non-fatal injuries as well as fatal injuries are identified in the societal dimension, we need to look at why and how injuries occur in the everyday life dimension and the life elements dimension. These two dimensions are a more micro level of the societal dimension. In the everyday life dimension, we need to find out what composes our daily life and how children interact with products in their lives. An integrative and comprehensive understanding of our daily life helps us see relationships among elements of the life elements dimension.

The life elements dimension consists of many sub-dimensions, such as the living organism dimension and product dimension. The living organism dimension helps us understand the mechanism of injuries from anatomical, medical or biomechanical perspectives. The product dimension is necessary to identify product characteristics or a particular feature of a product that cause injuries. The psychological dimension is another sub-dimension of the life elements dimension. To develop effective prevention strategies, one’s values, beliefs and attitudes toward practicing safe behaviors must be understood in the psychological dimension. The three dimensions, as shown in Figure 2 are also necessary to evaluate the effectiveness of injury prevention. A modified product from the product dimension needs to be used by people in the everyday life dimension. Effective product modification will be reflected by a reduction in injury occurrence in the societal dimension.

As discussed above, in order to prevent injuries, developing a new technology to handle all the dimensions together, and having people from different dimensions come together to establish research partnerships using the CBPR approach, are critical. The true meaning of partnering is to find as many B variables as possible, by integrating knowledge and skills obtained from different professionals from different dimensions and developing a precise injury control model.

The benefits of applying the CBPR approach to injury prevention are:

- Understanding the true cause of injuries in a defined community, based on data collected in the societal dimension.
- Development of injury prevention strategies, which are relevant for community members.
- Increased likelihood of the adoption of safe behaviors by community members.
- Establishment of a sustainable society that brings together people with different knowledge, skills and expertise, to prevent injuries.

3. LOVE & SAFETY OMURA STUDY: PROJECT OVERVIEW

The community-based participatory project named the “Love & Safety Omura Study” is an injury prevention program which was finally launched in 2011 after four years of preparation. In this project, community members in Omura City, Nagasaki, school officials, police and researchers work together to define community issues and find solutions by promoting co-learning and capacity building.

The Love & Safety Omura Study has two distinct features. The first is that the research topic is based on localized injury data. We analyzed injuries that occurred in Omura City to reflect the real problem in the community. Using injury data at a city level rather than at a national level makes the analysis results more relevant for community members. This analysis is done in the societal dimension. The second feature is that two Safety Knowledge Circulations (SKC) are integrated in this project (Figure 3). SKC is an injury prevention process to create safety. The SKC loop for the Omura community makes it possible for community members to participate in injury prevention research by providing injury data to researchers. In addition, safety knowledge created in a kids’ design community is circulated throughout the community. The SKC loop for the kids’ design community extends from data analysis to product/environmental modification to safety standard revision. Newly created knowledge in the SKC loop of the kids’ design community is then shared with community members.

![Figure 2: Three dimensions for injury control model](image)

![Figure 3: Dual safety knowledge circulation](image)
These two SKCs are usually independent of each other, which may interfere with effectively establishing safety. For instance, when two SKCs are independent of each other, safety knowledge produced in a community may not be used by a product designer, and, therefore, the designer cannot design the most appropriate products for children. Likewise, even if a new safety standard is established in the SKC for a kids’ design community, it may not be implemented throughout the community. In fact, a case of child drowning occurred in Japan even after a preventive strategy became available. Recent technological advances allow us to integrate all SKCs existing in different locations, making it possible to prevent future injuries in one place based on safety knowledge obtained from other locations. The Love & Safety Omura Study is the first study that utilizes knowledge and information gained from the SKC of a kids’ design community and that provides knowledge created in the SKC of Love & Safety Omura to a kids’ design community. Integration of two SKCs was achieved by dealing with the three dimensions simultaneously. This project has huge potential to move efforts in the injury prevention field forward.

4. COLLECTING LOCALIZED INJURY DATA

To collect data on injuries that occurred only in Omura City, we worked with one of our partners, the Medical Emergency Center of Nagasaki Medical Center, Japan. There were two kinds of data available for use. At first, we accessed data from the fire department on traumatic injury patients who were taken to the hospital by ambulance. We selected injuries that occurred in Omura, based on recorded locations where injuries occurred. Of the 1020 traumatic injuries that occurred in Omura between April 2009 and March 2010, 673 patients were taken to Nagasaki Medical Center. Then, we compared the data with patients’ admission data at Nagasaki Medical Center, to get information on available for use. At first, we accessed data from the fire department on traumatic injury patients who were taken to the hospital by ambulance. We selected injuries that occurred in Omura, based on recorded locations where injuries occurred. Of the 1020 traumatic injuries that occurred in Omura between April 2009 and March 2010, 673 patients were taken to Nagasaki Medical Center. Then, we compared the data with patients’ admission data at Nagasaki Medical Center, to get information on products related to injuries according to each age group of children, it is possible to design effective education programs.

5. RESULTS OF LOCALIZED INJURY DATA ANALYSIS

In this paper, we focused on children’s injury cases, which accounted for 99 of the 635 cases identified. Using data from these 99 children, we recorded sex, age, cause of injury and products related to their injuries. As shown in Figure 4, the number one cause of injury was falls (26 cases) followed by bicycle-related injuries (17 cases), car crashes (13 cases) and collisions (13 cases). The 0-3 year age group had the highest incidence of injuries. The number of injury cases decreased as children grew, increasing once again as they reached the age of 13 years (Figure 5).

Table 1 indicates specific products that were related to injuries. In this study, car crashes were removed from the analysis because most car crashes were not caused by children’s behaviors. Bicycles were most often involved in childhood injuries. Agricultural machinery or two-wheeled carts were also related to injuries, reflecting the regional characteristics of Omura. While it is well known that younger children have a higher risk of being injured, and that the types of products related to injuries vary with the child’s age, our analysis more specifically revealed the products that are related to each age group of children. For instance, bicycle-related injuries occurred most often among children over 12 years old while stairway injuries tended to occur among children under 6 years old (Figure 6). By identifying products related to injuries according to each age group of children, it is possible to design effective education programs.

![Figure 4: Types of injury](image1)

![Figure 5: Age-related incidence of injury](image2)

![Table 1: Products related to injury](image3)

![Figure 6: Example of child-product relationship in case of bicycle and stairs](image4)
As mentioned previously, children 0-3 years of age suffered the highest number of injuries. There is a limit on educating 0- to 3-year-old children on how to behave, and since they spend most of their time with their parents, it is important to educate the parents. Children over 12 years are old enough to understand the importance of helmet use. Our product analysis allows us to develop individualized educational strategies for injury prevention, taking into account the specific child-product relationship.

6. DEVELOPMENT OF DIGITAL CONTENT BASED ON THE HEALTH BELIEF MODEL

As a part of the Love & Safety Omura Study, we developed digital content based on the results of data analysis. Based on injury frequency and severity, we selected 5 injury topics: road traffic injury including bicycle-related injuries, burns, drowning, accidental ingestions and falls. These 5 topics are variable A in the injury control model. When designing health related educational material, it is critical to consider what information should be provided to a primary population. In this case, our primary population was parents who lived with children under 12 years of age. Information which will be provided to parents needs to be determined in the psychological dimension. Moreover, we also need to deal with the everyday life dimension because educational information needs to be utilized in parents’ daily lives and leads to parents’ behavior change.

As discussed before, education is one of the 3 Es for injury prevention. The purpose of education is to facilitate successful behavioral changes by giving new knowledge and skills that promote health. In order to develop effective interventions to promote healthy behaviors, we used the health belief model (HBM) developed by Irwin M. Rosenstock. The HBM is a health behavior change and psychological model and is one of the most widely used frameworks in health education. According to the HBM, perceived susceptibility and severity are important factors in initiating behavioral changes[6]. People are more likely to take actions if they believe that their chances of getting a negative health condition are high (Perceived susceptibility), if they believe that it could be very serious when they get it (Perceived severity), if they believe preventive actions available to them can reduce either their susceptibility to or the severity of the condition, and if they believe that benefits to taking the action outweigh its barriers (Perceived benefits and Perceived barriers). The HBM components are summarized in Figure 7.

We designed the digital content based on the HBM, especially aiming at perception of heightened susceptibility and severity of unintentional injuries among parents. In order to do this, we used two approaches. The first approach was to use local injury data to promote the perception of increased susceptibility. Usually, injury data from a state or national level are used to remind parents about the types of injuries their children are susceptible to. Although injury data at a national level tells parents about the general patterns of childhood injuries, their perceived susceptibility remains low because the information seems more distant, making it less impactful in convincing parents that an injury could occur to their child. Using more local data brings home the fact that injuries can actually occur in their own backyard.

Figure 7: Health belief model

Figure 8: Screenshots of animations that shows the process of occurrence of internal injuries

The second approach is to use animation for injury prevention education to promote perceived severity. We have designed 25 animations to depict how an injury occurs in daily life. Our previous study has shown that animation is less effective in promoting severity perception in injuries such as intracerebral hemorrhage and esophageal erosion caused by button battery ingestion. This is probably because in these types of injuries, bleeding is an internal phenomenon that is not visible from outside. Thus, we created animations that show how traumatic brain injury...
occurs inside the skull (Figure 8). This way, parents can easily perceive the severity of an injury.

We organized and formatted educational content for each injury topic. At first, with the help of electronic health records, we showed some examples of how an injury occurred. Then, we showed which body part was injured using a body graphic information system (BIS). BIS enables us to express, collect, retrieve and analyze external injury geometric data. We can see which body part is likely to be injured by selecting sex, child developmental stage, age in months, injury type, location where the injury occurred and cause of injury. Figure 9 shows which body parts were injured due to burns. The brighter area indicates a high frequency of injury.

![Figure 9: Screenshots of BIS in case of burns](image)

After providing written information on how injuries occur and the BIS picture based on the particular cause of the injury, we used animation to show how children are injured in their daily lives. Animations demonstrated the internal injuries resulting from falls from bicycles and from button battery ingestion. Then, we provided information on easy but necessary actions to prevent these injuries, such as pulling the plug on a bathtub and covering a TV’s remote control with a tape or plastic kitchen wrap. From the perspective of the injury control model, we carefully designed the content to work with parent’s behavioral changes (variable B) by enhancing parent’s perceived susceptibility and severity of injury. We showed this digital content at a health science workshop for community members held in Omura City in March 2011.

### 7. EVALUATION OF HEALTH SCIENCE WORKSHOP

Health Science Workshop evaluations were handed out after the workshop. The evaluation questionnaire contained questions regarding the basic knowledge of unintentional injuries, potential serious injuries that recently occurred, injury preventive measures that a respondent took at home, and the effectiveness of the workshop.

Approximately 23% of participants were parents, 8.4% were school board members and teachers, 26.5% were medical professionals, 2.4% were fire fighters or police officers, and 31.3% were others. About 65% of the respondents were aware that unintentional injury is the number one cause of death among children before attending the workshop. Although many participants already knew that unintentional injuries are among top public health issues in Japan, it is still under-recognized. Regarding the question for beliefs about injuries and injury preventability, most participants (96.4%) answered that it is possible to prevent injuries if community members, professionals, and caregivers work together to develop the injury control model. This indicates that we successfully delivered the message of “Injuries were preventable by collaborating each other” through the workshop. In addition, 73.5% of participants showed their intention to participate in the project as a resident in Omura City. With respect to the question about preventive actions which participants can take, they indicated effective strategies such as buying childproofing products, pulling the plug on a bathtub, and replacing the rubber seal for a hot water pot, which were introduced in the developed digital content. Moreover, we found out that participants were very interested in safety education and injury prevention program, especially bicycle safety education, for preschool and primary school children.

### 8. FRAMEWORK OF KNOWLEDGE CIRCULATION-ORIENTED CBPR FOR PROBLEM SOLVING

This section presents necessary steps to conduct community-based participatory research for problem solving. This will guide people who are trying to solve real life problems to develop an effective CBPR program.

There are seven steps.
1. Identify potential and initial stakeholders and call to action
2. Have a sustainable data collection and monitoring system (a surveillance system)
3. Address the causes of problems in a community and set priorities for problem solving
4. Develop or modify a control model for a targeted problem
5. Conduct a community-wide intervention based on the developed control model
6. Repeat Step 3 to Step 5
7. Celebrate accomplishments

**Step 1: Identify potential and initial stakeholders and call to action**

Medical professionals, product designers, engineers, psychologists, public health professionals, school teachers, participants representative of a community, other professionals and nonprofessionals come together and establish Knowledge Circulation (KC) for a local community and a multidisciplinary professional community. It should be revealed what challenges a community faced to start a KC-oriented CBPR project and assessed community readiness to undertake collaborative efforts.

**Step 2: Have a sustainable data collection and monitoring system**

Development of a sustainable data collection and monitoring system, such as a hospital-based injury surveillance system in case of injury prevention, is critical in order to efficiently gather reliable data. If the system is not yet available, be sure to make full use of existing data. It is important to note that data at a city level should be collected so that data analysis results reflect the real problem in the community.
Step 3: Address the causes of problems in a community and set priorities for problem solving
Based on data from the surveillance system, all involving stakeholders need to understand patterns, etiology, and characteristics of problems. Once community’s health priorities are determined, it is necessary to inform identified problems of other communities which can contribute to solution. (ex. The kids’ design community in case of childhood injury prevention)

Step 4: Develop or modify a control model for a targeted problem
Each stakeholder should contribute expertise to identify factors of each variable in the model and find the relationship between them. Variable B which can be altered for an effective intervention needs to be determined. Like the 3 Es of injury prevention, variable B should be considered from multidisciplinary perspectives. If needed, new stakeholders should be invited to find variable B.

Step 5: Conduct a community-wide intervention based on the developed control model
Newly created knowledge in a multidisciplinary professional community is circulated throughout a local community. Community representatives need to deliver the knowledge to community members and help them apply it to their daily practices. It is necessary to evaluate the effectiveness of an intervention. Evaluation results should be shared with local community members and professionals.

Step 6: Repeat Step 3 to Step 5
Knowledge circulation-oriented CBPR is a cyclical process to challenge real life problems. The impact of the intervention will be reflected on surveillance data, and it is necessary to repeat Step 3 to 5 continuously.

Step 7: Celebrate accomplishments
Celebration should be held regularly to confirm that community members’ participation is successfully engaged in action. It will generate publicity for a project and attract new partners. It will also be an opportunity to empower all individuals who involved in a project and ensure to sustain future efforts.

These proposed seven steps will help individuals who are interested in implementing knowledge circulation-oriented CBPR to solve real life problems in their communities. The most important thing is that, while recognizing strengths each stakeholder brings, community members and professionals from different disciplines work together to construct a control model, obtain a clear picture of the mechanism of a problem, and determine variable B.

9. FUTURE DIRECTIONS FOR RESEARCH

The Love & Safety Omura Study is expected to contribute to future injury prevention research by demonstrating the effectiveness of applying a community-based participatory research approach. In future studies, taking the community members’ request into account, we are planning to implement an educational program for bicycle helmet use among primary school children. We currently examine whether localized injury data increase parents’ perceptions of the susceptibility of children to injury, as well as how animations showing the inside of the body affect parents’ perceptions of injury severity. Moreover, we calculate total medical costs as a result of injuries that were occurred in Omura City. The findings from the present research will be invaluable in designing future education programs. Most importantly, expanding partnerships with new communities will be a primary focus of our project.

9. CONCLUSION

Employing a CBPR approach allows the development of the injury control model and the identification of changeable variables (variable B), which results in the greatest reduction of injury occurrence and severity. We also discussed three dimensions, consisting of the societal dimension, the everyday life dimension, and the life elements dimension, for injury prevention. Injuries should be understood from multidisciplinary and multidimensional perspectives by bringing people with different skills and knowledge together. In order to apply a CBPR approach including multidisciplinary and multidimensional perspectives, we implemented the Love & Safety Omura Study. We pointed out two unique characteristics of this project: 1). city-level injury data were used to give priority to the local community and 2). a dual system of SKC was employed. We analyzed all injuries in children up to 18 years old who visited the emergency department at Nagasaki Medical Center to determine injury prevention priorities in Omura City. There were a total of 99 admissions between April 2009 and March 2010, and fall injuries were the number one cause of injury. We also found that bicycle-related injuries were a top priority for Omura. In the present study, digital content was designed to increase parents’ awareness of the susceptibility of children to injury and of the severity of potential injuries. Animations that showed the inside of the body were used to promote parents’ perceived severity of an injury. Lastly, we proposed the seven steps to implement a knowledge circulation-oriented CBPR for problem solving. We hope that our suggested approach will be applied in future research in various fields and that created new knowledge can be shared worldwide.

10. REFERENCES