An exploration of informed risks and responses related to nuclear weapons with consideration of the global to local implications

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Abstract

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Context: Recent rhetoric regarding nuclear weapons has reignited concern from global to local levels. Consequently, conversation has gained traction as real and perceived tension between nuclear states has escalated. This study aims to explore the humanitarian and health risks associated with nuclear weapons.

Methods: Qualitative data was gathered through eleven in-depth interviews of individuals versed on the topics related to nuclear weapon risk and response. Participants were identified using purposive and snowball sampling methods. Interviewees represented backgrounds in emergency response, public health, environmental science, health security, global and national security and policy, and peace advocacy.

Results: Analysis yielded five key themes: awareness, risk and threat, impact and consequence, mitigation, and preparedness, as well as thirteen subthemes. Interviewees highlighted the

recent, dramatic increase in political and public awareness related to nuclear weapons following the rise in tension. Interviewees further agreed that nuclear weapons pose a risk by their very existence and that the impact and consequence of a nuclear detonation would depend on the conditions of use. A nuclear incident is viewed as unlikely, though interviewees acknowledged there would be high consequences if one occurred. Respondents in this study expressed that the risks from nuclear weapons could be mitigated but not prevented, highlighting the importance of mitigation strategies such as diplomacy. Interviewees further discussed both global and local shifts in preparedness, noting a tension between the need for education and creation of panic.

Conclusions: The sustained stockpiling of nuclear weapons continues to pose significant humanitarian and health risks across the globe as well as locally here in the Pacific Northwest. Public health professionals can educate the public on the risks related to nuclear weapons and advocate for nuclear disarmament. Additionally, there is a need for increased diplomacy globally, with respectful discussion amongst allied and adversarial nations.

INTRODUCTION AND BACKGROUND

Recent public rhetoric between nuclear state actors has sparked renewed concern and discussion at global, national, and local levels about the use and role of nuclear weapons in modern society. Russia, China, and the United States have all declared plans to modernize their nuclear programs and create new nuclear weapons, bringing up memories of the Cold War and fears of a potential new arms race.[1-5] Heated exchanges between the leaders of the United States and North Korea, including threats of attack or retaliation, has further raised tensions and public consciousness.[6-9] Is there a cause for concern? This thesis sets out to explore the perceived risks of and responses to nuclear weapons, including global to local implications.

Global

Since the height of the Cold War in 1986, the global nuclear weapon stockpile has substantially decreased—from 64,099 to an estimated 9,220 in 2017.[10] This dramatic decline is the result of a series of treaties signed by both Russia, formerly the Union of Soviet Socialist Republics (USSR), and the United States dating back to the 1960s.[11-13] In 1963, the Partial Test Ban Treaty (PTBT) was first signed by the USSR, the United Kingdom, and the United States, before opening to other countries.[14] Its signatories agreed to limit nuclear weapon testing to underground facilities.[14] The Treaty on the Non-Proliferation of Nuclear Weapons (NPT) followed in 1968 and marked the start of a global shift to limit nuclear weapons.[15] Under this treaty, nuclear-capable states agreed to limit their arsenals and non-nuclear states affirmed their commitment not to seek out nuclear weapon capabilities.[15, 16] The NPT became binding in 1970, and currently has 191 signatory countries—all countries except the undeclared nuclear

states and South Sudan, which was founded in 2011.[15] Despite this decline, nuclear weapons still pose great risk of harm.[11]

Nine nuclear states exist today.[10, 16] They are comprised of five states who are formally recognized by the NPT (China, France, Russia, the United Kingdom, and the United States) and four nuclear states undeclared under the NPT (Israel, India, North Korea, and Pakistan).[12, 15, 16] In 1991, the USSR dissolved and all Soviet-era nuclear weapons were transferred to Russia.[17] Russia, China, and the United States have all stated intentions of modernizing their nuclear arsenals and creating new nuclear weapons in recent years, raising concerns of a new arms race.[1-5] North Korea's active testing of nuclear weapons and threats against the United States have further heightened tensions across the globe.[8, 9, 18] Terrorist groups who are actively trying to build, buy, or steal nuclear weapons present another threat.[19]

Increased threats have prompted several countries and territories to mobilize nuclear preparedness campaigns. In Japan, the government is seeking to increase public preparedness by running "missile defense training alongside regular safety drills," especially in schools.[20] Sweden has issued a public information manual, increased defense spending, and instructed towns to re-establish "Cold War-era civil defense contingency plans."[21] The United States territory of Guam has also sought to prepare their public, issuing a nuclear preparedness fact sheet following North Korea's explicit threat of attack.[22] Additionally, the Hawaii Emergency Management Agency has initiated warning measures not seen since the Cold War, running monthly tests of a new nuclear warning siren and drills.[23] However, drills have been halted after an alert was sent out in error announcing an imminent threat early on January 13, 2018 led to widespread panic and confusion on the island. [23]

These actions have contributed to international campaigns for disarmament. In July of 2017, the United Nations (UN) adopted the Treaty on the Prohibition of Nuclear Weapons calling for total elimination of nuclear weapons.[24] This historic treaty prohibits the development, testing, production and use or threat of use of nuclear weapons.[24] It has received wide support from non-nuclear weapon states, receiving 122 votes in favor of the final text and has 58 signatories, to date.[18, 24] However, it has been disregarded by all nuclear weapon states.[18] These conflicting visions of the future highlight the need for continued discourse on nuclear weapons at the international level.

National

The United States holds a unique position in the history of nuclear weapons, as the first country to build nuclear weapons and the only country to utilize them in armed combat.[12, 13, 16] The US has held conversations on non-proliferation and disarmament, and signed the NPT.[11, 12, 15] At the same time, its nuclear policy has been based on deterrence since the Cold War, asserting that a nuclear arsenal is necessary to ward off nuclear attack from other states and to dissuade non-nuclear states from starting nuclear weapons programs.[25] Former President Obama notably called for a world without nuclear weapons during a 2009 speech in Prague.[19] He then released his 2010 Nuclear Posture Review (NPR), which stopped development of new nuclear weapons, sought the retirement of submarine-launched cruise missiles (SLCMs), and ruled out attacking compliant NPT non-nuclear weapon states.[25, 26]

In contrast, the Trump Administration's 2018 Nuclear Posture Review seeks to reaffirm the US as a nuclear power through the development of modern SLCMs and exploration of low-yield nuclear weapons.[5] It also leaves room for use of nuclear weapons against "significant non-

nuclear strategic attacks."[5] However, it asserts that the US would only use nuclear weapons in extreme circumstances.[5] The 2018 NPR notably rejects the 2017 UN Treaty on the Prohibition of Nuclear Weapons, and the Trump Administration will not move to ratify the Comprehensive Nuclear Test Ban Treaty (CNTBT), which prohibits nuclear testing in all environments.[5] This most recent NPR has drawn initial concern from nonproliferation and peace advocates, while being heralded as a welcome and necessary change in policy by deterrence supporters.[27, 28]

Local

The threat of a nuclear attack from North Korea hit close to home in the Pacific Northwest as the city of Seattle was seen as a reasonable target for attack.[29, 30] Seattle's dense population, technological centers, and relative proximity to North Korea all add to its attractiveness as a target.[29] Additionally, Seattle is situated only 20 miles from numerous military installations—most notably the Bangor submarine base in Kitsap, WA.[29-31] The Bangor submarine base and adjacent storage facility, later referenced as Trident sub base, is believed to store more than 1,300 nuclear warheads between what is on land and deployed on submarines, roughly twenty-five percent of the US nuclear stockpile.[30, 32] Though experts estimate that North Korea is several years away from having the ability to launch weapons that can reach the West Coast, these concerns started to shake political and public consciousness.[29] The possibility of an attack also raised questions of potential risks from having such a large stockpile of nuclear weapons within the state and the state's preparedness to respond to a nuclear incident.

In 1984, the Washington State legislature chose to prohibit the "preparation for emergency evacuation or relocation of residents in anticipation of nuclear attack" in its

comprehensive all-hazards emergency plan.[33] The provision served two functions. The first, was a firm rejection the Federal Emergency Management Agency (FEMA) promotion of evacuating large portions of the population as a realistic preparedness measure in the face of a nuclear attack.[34-36] The second, was to encourage goodwill as tensions with USSR were waning.[37] This little known provision has caught the attention of current legislators, the media, and the public, as nuclear attack concerns have resurfaced.[31, 35, 37] Lawmakers today are concerned that the 1984 law could prevent preparation.[31, 36, 37] During the 2018 Legislative session, State Senate Bill 5936 and House Bill 2214 sought to lift the ban.[38, 39] One of the sponsors, Senator Mark Miloscia, stated that the region has changed and expressed that we are "more sophisticated at emergency planning," indicating that we should put resources to preparing for all threats, including nuclear.[37] Both bills were publicly heard in committee, received executive action "do pass" majority recommendation and moved to their respective Rules Committee's where they died in session, but may be reintroduced in 2019.[38- 41]

Public Health

The bombings of Hiroshima and Nagasaki in 1945 killed an estimated 200,000 people and left many more with long term health complications.[16] Today, those weapons, at 15 and 20 kiloton yields, respectively, are considered low-yield.[42] Nuclear weapons in the US and global arsenal are substantially more powerful creating an even greater public health risk.[43, 44]

The use of nuclear weapons has devastating immediate and long-term health and social effects.[11, 16, 45] Exponentially stronger than conventional weapons, the World Health Organization (WHO) summarizes that a nuclear weapon "produces a blast wave, a thermal wave, instantaneous radiation, radioactive fall-out, and an electromagnetic pulse."[46] Combined

in a nuclear detonation, these forces cause immediate death and destruction, impair electronic devices and communications, and damage infrastructure, all of which can hinder emergency response and health services.[46] In the days, weeks, and months following an attack, many initial survivors will succumb to injuries sustained by the blast, burns, or subsequent radiation.[46] Of those who survive, many will face long-term health problems, including the possibility of passing on genetic irregularities.[11, 46] Additionally, the environment, economy, social structure, and health services suffer long-term harm.[11, 45, 46]

The existence of nuclear weapons remains a global risk today.[19, 45] This descriptive study aims to depict the informed perceived risk of the continued existence of nuclear weapons, possible strategies to mitigate or prepare for nuclear attacks, and the potential health and social effects of a nuclear weapon detonation. Its specific aims seek to answer:

1) What are the perceived risks of nuclear weapons today?
2) What would be the likely consequences of a nuclear weapon detonation today?
3) What strategies, if any, exist to mitigate this risk?
4) What, if any, measures for preparation could be taken to help people avoid harm?

METHODS

This descriptive, qualitative study used in-depth interviews with key informants to better understand perceived risks related to nuclear weapons, the expected consequences of nuclear weapon detonation from attack or accident, and strategies for possible mitigation and preparedness at a global, national, and local level.

Key Informants

Interviews were conducted with local, regional, and national experts and professionals. They were selected based on their experience and knowledge of nuclear weapons, risks associated with nuclear weapons, disaster preparedness and response, and measures or legislation around nuclear weapons and/or materials. This study aimed to have participant representation from those in government, non-government organizations, the health sector, environmental science, and disaster preparedness and response.

Recruiting, Screening, and Consent

Participants for key informant interviews were identified and recruited based on their experience and knowledge of the topics noted above. Initial subjects were identified by roles or positions held in relevant fields, and from published or referenced material in the literature review. Snowball sampling methods were used to identify additional potential participants.

Participants were approached by the principal researcher in person, by phone call, or via email, provided with a brief overview of the study, and invited to participate. All interested participants were given a consent form detailing the project, informing them that their participation was voluntary, and that they could refuse to answer any questions at their discretion. All interviewees were told they would be given the opportunity to review and approve any direct quotes referencing them in final work (see appendix B). Those who granted consent to participate were interviewed by the principal researcher in person or over the phone.

Inclusion and Exclusion Criteria

Eligible participants were adults with experience or knowledge pertaining to the topic of nuclear weapons, disaster preparedness and response, health outcomes, risks associated with nuclear materials, or measures around nuclear weapons or materials.

Data Collection and Analysis

Data was collected through open-ended semi-structured interviews (see appendix C). All interviews were conducted by the lead researcher and either held in person or over the phone, depending on location and availability of the participant. Interviews lasted 30 to 45 minutes and were recorded with permission and were transcribed following the interviews. Interviews were analyzed for thematic content using traditional text analysis through an iterative process, using both a priori and emergent coding.

RESULTS

Twenty-three individuals and organizations were approached for participation in this study, with a positive response rate of 78%. Of those respondents, eleven were willing to participate in the in-depth interviews, two were willing to provide brief comment, and the remaining five either deferred to another individual or to an organization's website. Interview participants represented backgrounds in emergency response (interviewees #1 and 2), public health (#3), environmental science (#4), health security (#9), global and national security and policy (#5, 10 and 11), and peace advocacy (#6, 7 and 8). Participants also represented expertise at local, regional, and national levels.

Awareness

All interviewees described a recent, dramatic increase in political and public awareness related to nuclear weapons. Interviewees attributed this boost in awareness and concern with the advent of threats from North Korea and the political antagonism between the leadership of North Korea and the United States. Increased media coverage was often given as the reason for this rise in public awareness.

> *I think there has been a huge increase in the political happenings and social awareness with nuclear weapons lately… Nuclear weapons are back on the political agenda, back in the news, and on people's radars.* (Interviewee #7)

> *Last fall [2017] caused a spike in concern, at the media level. We saw some of that concern expressed in the legislature and we saw some of it expressed in the public. I don't think that the threat is there yet because I think that he [Kim Jong-un] is still working on his capabilities. But it was a tremendous wakeup call both for our political structures and our society that this threat still really is out there and yes, we really do need to pay attention to it.* (Interviewee #1)

Interviewees further described the historical shifts in public awareness and action from the early days of nuclear weapons to today. Many interviewees (#1-3, 5-11), recounted similar heightened tensions during the Cuban missile crisis and throughout the Cold War. After the Cold War, interviewees described a decline in public awareness.

> *During the Cold War missile crisis time, it seems like… everybody was talking about it… People knew there was some kind of plan and had an idea of where to go… it was something terrible that could happen that we sort of accepted as part of daily life.* (Interviewee #6)

> *We've lived under the threat of nuclear weapons for a couple of generations now. I think of when they were new, society was very much aware of and in tune to the threat posed by nuclear weapons. You had a pretty active civil defense culture of fifties and the sixties… But I think as we went into the eighties and nineties you have the fall of the [Berlin] Wall. I think the awareness, perhaps among our society, diminished a little bit, and saw the threat as being not quite as prevalent as it was.* (Interviewee #1)

Several interviewees (#1, 6, 8, 10 and 11) discussed how the heightened awareness during the Cold War led to organizing and activism. However, the increased awareness today does not seem to be creating the same urgency. Interviewees also referenced a different level of knowledge and awareness, from that during the Cold War.

> *When you look at the late seventies, early eighties, the Sane-Freeze movement was something that drew in thousands of people… They were all [there] with one very specific goal, which was just to freeze the arms race… I feel like people were super aware at that time in a way that they are not now.* (Interviewee #6)

> *In the eighties it was widely discussed of course, the media covered it. Locally there were demonstrations at the sub base, it was big news, and today there's less and less coverage. We still have similar demonstrations, but not as big. And you know, in the eighties people knew what the Trident sub base was.* (Interviewee #8)

Interviewees (#6, 7 and 11), further described a perception of apathy amongst the public.

> *It's not really on people's radar screen, with the exception of what happened very recently with Trump [and North Korea]... I think since the end of the Cold War people haven't thought about it much, and I can't imagine that that will change unless something horrible happens.* (Interviewee #11)

Risk and Threat

All interviewees agreed that nuclear weapons pose a risk to society, by their very existence. Several interviewees (#5, 9 and 10) felt that the risks posed by nuclear weapons had increased in recent years. Additionally, interviewee #10 discussed that the diversity of nuclear weapon states also contributed to the increase threat and risk.

> *I believe they pose a risk. I think anytime something that exists that could harm or take a human life it's a risk...The availability of nuclear materials, nuclear attack is absolutely a risk.* (Interviewee #2)

> *… if you have weapons with the capacity for tremendous destruction, there's always a risk there of political escalation getting to the point where they could be used.* (Interviewee #1)

> *I think one way to think about it is, when you continue to do something for years, even if the probability of any given year is low, the added-up probability that at some point there will be one used is much higher.* (Interviewee #11)

> *The diversity of [nuclear states] is much greater than we saw in the Cold War… My claim is that since there's more nuclear weapons actors, that really one of the critical variables, not simply the number of bombs per say.* (Interviewee #10)

Terrorist groups

Many interviewees (#1, 2, and 5-10) expressed concerns of terrorists seeking out nuclear weapons or materials. Non-state actors and terrorist groups were described as an ongoing threat in contrast to risks from nuclear weapon states. Interviewee #1 further discussed how instability in the global system can increase risk of use by rogue nation actors or terrorist groups.

> *There's a known active underground market for dealing and trading nuclear materials by terrorist groups. There are documented cases every single year of nuclear material being traded or being attempted to be traded.* (Interviewee #7)

> *At the same time, I'm worried about the threat of nuclear terrorism, given the global stockpile of fissile materials… The projection [is] that there's enough fissile materials to make more than 120,000 crude nuclear devices. There's a proliferation problem that could lead to a nuclear terrorist scenario...* (Interviewee #9)

> *The greater threat, is in the area of rogue nation actors wanting to use them or potentially non-governmental terrorist groups... I think that the more de-stable or unstable our global systems are the greater these weapons produce a risk. If you have a nation, or a group, with a stated desire to obtain and threaten their neighbors with them, to the degree that they can be influenced or not influenced by global [systems]. The global neighbors run that risk of instability and use, or the situation escalating to where the unthinkable all of the sudden becomes thinkable.* (Interviewee #1)

Accident and unintentional attack

When asked about the possibility of a nuclear accident occurring, most interviewees (#1, 2, 4-7, and 9-11) described it as possible, but unlikely. Interviewees cited increased tensions and political antagonism as factors that increased the risk of accidental use. Several

respondents noted that even though the global nuclear weapons arsenal had decreased in number overall, a large number of weapons remained on high alert.

> *What I'd worry about a little bit more, is the prospect of an accident in the event of an ongoing crisis. If there is already a crisis or a war, the countries are… putting the nuclear weapons on high alert. Then in that kind of context, I think there is a greater risk of accident or inadvertent escalations.* (Interviewee #5)

> *There have been many, like thousands, of documented cases of accidents and near misses. Times we've come within minutes of somebody launching them or believing that we needed to launch nuclear weapons during the Cuban missile crisis, but also other situations. Even without the threat of conflict, there's so much opportunity for error and the implications of that would be devastating.* (Interviewee #7)

Interviewees #5 and 10 indicated that newer nuclear weapon states are more vulnerable to accidents as they have limited safeguards. Interviewee #10 elaborated:

> *The chance of an accident is also going up, particularly among the new nuclear weapons states like Pakistan or North Korea… they don't have a lot of management experience for handling these things. Not only is it going up, but the consequences of it are rapidly going up, and no one has noticed this.*

Some interviewees (#6 - 8) worried that a cyber-attack or false alarm could trigger an actual response.

> *There's this interesting dynamic as we switched more to technological security and command and control systems, there's a heightened risk of cyber-attack to those. The national nuclear security administration has reported getting millions of cyber-attacks per day.* (Interviewee #7)

> *There are a lot of people who think that our weapons being as old as they are makes them unsafe likely for errors. There's jokes about some of the missiles running on floppy disks, but then as you move from floppy disks to more modern technology, the technology is more corruptible.* (Interviewee #6)

Several respondents (#6-9) expressed knowledge of nuclear accidents or near misses that have occurred within the United States. Interviewees stated they believed that the risk of an accident persists today.

> *From a plane carrying bombs in North Carolina that accidentally dropped them, to missile silos catching on fire, two different fires in Arkansas strangely. I think them just being around presents risk.* (Interviewee #6)

> *There's been some historic near misses, I don't have the details on those, but it's enough to scare me. That possibility is quite real and certainly is not going away.* (Interviewee #9)

Additionally, respondents (#1, 4, 6 and 7) wondered if there could be risk from a natural disaster such as an earthquake or tsunami. The 2011 tsunami that led to the meltdown of three nuclear reactors in Fukushima, Japan, was cited as an example. Interviewees who talked about natural disasters felt that the risk remained low, but as with any nuclear detonation, the consequences could be high. Interviewees expressed concern that older military buildings and storage facilities may not be fully retrofitted for events such as earthquakes. Many also expressed uncertainty about what the military and specifically the Navy has done to mitigate these risks.

> *Puget Sound is relatively well protected, so a tsunami coming down the Juan de Fuca Strait or generated within Puget Sound is not going to be a huge… The hazards come from two things: from the ground motions...and then a tsunami that might a slosh back and forth at a height of one to two meters for a number of hours... These are kinds of things that are relatively easy to manage in a well-constructed facility, but poorly constructed facilities, as most of ours are in the Pacific Northwest, don't perform well under even modest shaking and tsunami action.* (Interviewee #4)

Several interviewees (#1, 4, and 5), expressed knowledge or belief that safeguards and security measures were in place to prevent or minimize accidental risk.

> *The possibility is always out there that something could happen, but I think that there are pretty strong and stringent safeguards in place to minimize the risks.* (Interviewee #1)

Low risk, high consequence

Despite posing a risk, nearly all respondents (#1-7, 9-11) indicated that they felt the likelihood of a nuclear attack was low, but that it would have high consequences if one occurred.

> *I think it's unlikely. That being said, I can still think of scenarios in which they could be used. But again, unless you have a regime that is completely indifferent to its survival, there is a strong deterrent out there against their use of nuclear weapon… And so, unless they are in the hands of people who are completely irrational, completely indifferent to their own survival, the chances of these things being used, is probably very slim.* (Interviewee #1)

> *I think simply that they exist, they can be used, that it is a low risk possibility, but high consequence possibility.* (Interviewee #3)

Impact and Consequence

In discussing the effects of a nuclear weapon detonation today, all interviewees who commented (#1, 2, 5-11), stated that impact and consequences would depend on conditions of use. Interviewees described that the size of weapon, where it was used, and how it was delivered would all impact the magnitude of its effect. However, all interviewees stated that the consequences of a nuclear weapon would be devastating. Interviewee #7 further noted that nuclear weapons today are substantially more powerful than those used during the World War II bombing of Hiroshima and Nagasaki.

> *It depends on the type of attack. If it was a full-scale exchange, there probably wouldn't be much left here… If there's one nuclear weapon that would be very different and there might be ways that people could survive it.* (Interviewee #8)

> *The bombings of Hiroshima Nagasaki are the most brutal and destructive examples of war that we've ever seen. An almost unimaginable tragedy in and of themselves. The effects today would be so much worse than that. It is truly almost unimaginable, I think, for us to conceive of what that would look like.* (Interviewee #7)

Interviewee #1 went into more detail describing the immediate impacts of a nuclear attack:

> *It's going to impact the economy, the society, our political structures for generations to come, and how we're going to deal with that and absorb it. I think you've got to go back to look at Hiroshima and Nagasaki here. You can see the impact on the national psyche in Japan following that event and we would be seeing similar concerns here. If you want to go down the nuclear accident line of thought. All you have to do is look to Chernobyl, and to a degree Three Mile Island, and over to Fukushima to look at the social and the environmental and economic impacts following those types of events. You would see very similar things happening here.*

Nuclear war

In a nuclear war between nuclear nation states, multiple nuclear weapons would likely be exchanged. This would increase the level of destruction, loss of life, and long-term impacts. Interviewees (#1, 5-8, and 10) noted that a nuclear war today would have catastrophic implications. Interviewee #10 further discussed how a nuclear war would send radioactive fallout throughout the world.

> *It's one of the few threats, maybe in addition to long term climate change, that could threaten human existence. Nuclear war with Russia is really the only threat on earth that means that 100 million Americans could be suddenly dead tomorrow. So, it's a very serious threat. Fortunately, the probabilities are low.* (Interviewee #5)

> *Another example is a nuclear war between Pakistan and India, which could reach a size with a really significant radioactive fallout on the world.* (Interviewee #10)

Single nuclear detonation

A single nuclear weapon of large capacity could still have a large effect on society. That impact would depend on its size. Even in considering a single nuclear detonation, interviewees noted its effect would still depend on factors such as size and location of detonation. Interviewee #1 questioned whether a single nuclear attack could even occur in the current climate without a retaliation.

> *It depends a lot on the type of nuclear weapons and where it's used. A low yield nuclear weapon, detonated in the earth's atmosphere over the ocean, if North Korea were to conduct some kind of atmospheric nuclear tests, there could be minimal consequences.* (Interviewee #5)

> *Now if someone drops a 10 kiloton, that's another range. If someone drops a 200 kiloton, that's a whole other range… As we know, in a 10 to 200 kiloton attack, there's going to be tens or hundreds of thousands of instant deaths and there's going to be hundreds of thousands more slowly occurring, with dire health impacts. There's going to be areas of a community not habitable again. If it's a small localized incident, there's cleanup available and we go on with our lives as usual.* (Interviewee #2)

Another consideration is the use of an improvised nuclear device (IND) or dirty bomb, which would more likely be used by a non-state actor or terrorist group. The impacts of detonation could be similar to those previously described, depending on size and location of detonation. Interviewee #9 discussed possible IND scenarios in depth, stating:

> *There's a lot of modeling that's been done about the improvised nuclear device detonation scenario in a major city… If we take that scenario, there's a mass destruction epicenter. Then you have the secondary and tertiary effects that come with mass population displacement. Then the lingering effects of a decontamination challenge in the radiologically affected areas.*

Interviewee #10 had a different view of the likely consequence of an IND noting:

> *What happens, is the dirty bombs that most groups would be able to make, would do harm, but most of the damage would come from the high explosive part of the device not from the radiation. I think we would still be talking about, if you're pessimistic, hundreds of casualties, not thousands…*

Mitigation

Interviewees felt that as long as nuclear weapons existed, there was no way to prevent an incident, but that options existed to mitigate risk. The key sub themes that emerged under mitigation were diplomacy, deterrence and disarmament, treaties and policies, and terrorist threat.

Diplomacy

All respondents (#1, 2, 5-7, 9-11) who discussed mitigation measures, listed diplomacy as a key strategy. Interviewees further highlighted the need for discussion, understanding, and

respect between countries. Interviewees #6 and 8 expressed that respect and a historical understanding were needed for diplomacy, particularly engagement with North Korea.

> *I believe it's a more mitigatable risk because it's not naturally occurring and it's politically and intentionally used. I think a good example of good mitigation measures to protect us from this very real risk is good diplomacy.* (Interviewee #2)

> *There was the North Korea thing last week, that if they didn't feel they needed to use them, they wouldn't use them. It kind of tells the whole story. Sitting nation to nation, with respect, coming to the table, not demanding. The US has historically demanded that North Korea cease and desist all nuclear activities before we even come to the table, and that's just a non-starter.* (Interviewee #6)

Interviewee #9 expressed that diplomacy would be harder in a nuclear terrorist scenario than in state to state negotiations.

> *… it really is about interrupting plan[s] to use fissile materials in an improvised nuclear device. So, there's less of a diplomatic column there and more in terms of technological forms of prevention.* (Interviewee #9)

Deterrence and disarmament

Respondents were divided on their views of deterrence versus disarmament. Interviewees (# 1, 5, 10, and 11) discussed deterrence as the current and historical US strategy for prevention of nuclear war. Interviewee #5 felt that deterrence was the foremost strategy. However, interviewee #10 indicated that while deterrence was the legacy strategy of the US, it may not be keeping pace with the changing strategic environment.

> *The foremost strategy is deterrence. The United States using its nuclear weapons to deter adversaries from using their nuclear weapons. So that's number one.* (Interviewee #5)

> *The overwhelming strategy we embrace is deterrence, which is the threat of a retaliatory strike with our surviving nuclear force, which would be so damaging that no rational leader would choose to launch the attack in the first place. This has been around since the early Cold War and is the strategy of the United States… the world has changed considerably since the Cold War because now we have potential attackers such as China and North Korea, which were really not a threat during the Cold War, more precisely they were not nuclear threats.* (Interviewee #10)

On the other side of the spectrum, interviewees #6 and 7 advocated for disarmament. Interviewee #7 noted the global shift towards disarmament, which they felt was minimized as an option in the US. Interviewee #7 stated that disarmament was the best strategy to mitigate risk from nuclear weapons.

> *Globally there has been renewed interest in really moving towards disarmament, not just talking about it. I feel like we don't hear that a lot in the US. We didn't participate in those discussions. There is a presumption in the US that we have to have our nuclear arsenals to keep us safe.* (Interviewee #6)

> *A lot of people say that the only 100 percent stable way to ensure that nuclear weapons are never used is to not have nuclear weapons. If we have nuclear weapons at all, they will at some point be used by accident or on purpose… Working towards disarmament is the best way to minimize the risk.* (Interviewee #7)

Treaties and policies

Interviewees also noted several international treaties aimed at limiting the spread of nuclear weapons and the need for additional policies as pathways for mitigation. Respondents (#6, 9 and 11) specifically referenced the 1968 Treaty on the Non-Proliferation of Nuclear Weapons and the 2017 Treaty on the Prohibition of Nuclear Weapons as strategies to keep nuclear weapons and armed states to a minimum.

> *Then of course, the treaties in terms of a nuclear non-proliferation, it's trying to keep the number of nuclear arms states to a minimum. It's certainly a form of prevention as well. So, for people who have it, cut it back and rely on diplomacy for any political animosity, and from a global perspective, keeping the nuclear arms states to a minimum number.* (Interviewee #9)

> *The non-nuclear states have been becoming increasingly unhappy with the progress of the nuclear weapons states. Last year [2017], they negotiated a treaty banning nuclear weapons. I think that was really an indication of the global climate…* (Interviewee #11)

Interviewee #10 expressed frustration at the limited conversations taking place between governments on arms control. They noted that we now live in a world "which is a multi-polar

nuclear world rather than a bipolar nuclear world, like the Cold War was," and therefore needed a new framework that takes into account all nuclear state actors.

> *We still engage in arms control talks, but only with Russia, as if the only two countries that mattered were the US and Russia. When In fact there's nine countries now, that matter. In fact, most people would argue that North Korea is more likely to fire a nuclear weapon at the United States than is Russia.* (Interviewee #10)

Interviewee #6 felt that pressure on Congress was needed to advance US policy to "prevent us from offensively launching a nuclear weapon," and suggested grassroots organizing could accomplish this goal. However, interviewee #10 stated, "I don't think the Congress feels any pressure from below, from their constituencies, at this point."

Terrorist threat

Many interviewees (#1, 2, and 5-10) expressed concerns of terrorists seeking out nuclear materials, and several interviewees (#5, 8, and 9) noted the need to secure nuclear weapons and fissile material. Respondents indicated a belief that measures were being taken by governments and intelligence agencies to secure and surveil fissile material and nuclear weapons.

> *Certainly there's surveillance to track any mobility [of terrorist groups] and fissile materials. There's the intelligence that's related to actors who are actively seeking to sell materials or technological knowledge that they can apply in using fissile materials. So, that's a little bit harder in terms of diplomatic prevention activities and it really is about interrupting plan[s] to use fissile materials in an improvised nuclear device.* (Interviewee #9)

Preparedness

Global shifts

Several interviewees (#1, 6, 7 and 10) described global shifts towards preparedness in response to recent rhetoric around nuclear weapons. They discussed that some countries, such

as Japan and Israel, were taking steps to bolster their civil defense programs while others, such as Guam, were running drills and public information campaigns. Conversely, interviewee #7 noted that nuclear weapons states, such as Russia, are moving to bolster their nuclear programs as a means of deterrence. Interviewees felt that these actions were representative of present tension in society.

> *It is actually a little bit scary… several countries bolstered their civil defense programs including Japan, including Israel, including, I believe, some of the Scandinavian countries who are concerned about a war with Russia. I view it as a barometer of how scared the society is.* (Interviewee #10)

> *Vladimir Putin gave the State of Union address, in which he talked about bolstering their nuclear weapons arsenal… I think this is an indicator of the times we're in. I think there is this ratcheting up again rhetoric between nuclear weapons states to show who's the strongest.* (Interviewee #7)

National Preparedness

In contemplating preparedness for a large-scale attack within the United States, respondents (#1, 5, 7 and 10) referenced the civil defense strategies of the Cold War and the federal missile defense system. However, interviewees questioned how effective these measures would be in the event of an attack. Ultimately, interviewees indicated that very few defenses or preparation existed for a nuclear attack.

> *During the Cold War, there were a lot of civil defense measures that were undertaken. Efforts to plan for a system of fallout shelters for example, where people could take cover in the event of a nuclear conflict… Missile defenses are another type of defense. Having systems to try to shoot down enemy nuclear weapons as they approach one's territory. But in general, that's a no. There are very few real defenses against a nuclear attack and that's what makes it so devastating.* (Interviewee #5)

> *Very little capability to manage a certain incident. Let's be clear here. I'm talking here about a North Korean nuclear attack on Seattle or possibly San Francisco. Um, we really can't, we have missile defenses. We just don't know how well they'll work, but I don't know anybody that has high confidence in them.* (Interviewee # 10)

In considering preparedness strategies related to a smaller nuclear weapon incident, specifically an IND, some interviewees (#3, 5 and 9) felt there was a level of preparedness that could occur. Several respondents (#2, 3, 6 and 9) cited Ventura County in California as an example of areas that have taken preparedness steps and engaged in public awareness campaigns in preparation of an IND. Additionally, interviewee #9 spoke about the Urban Area Security Initiative (UASI) sponsored by the US Department of Homeland Security (DHS) that modeled an IND in several major US cities and provided money for comprehensive emergency planning.[47, 48]

Washington State

Interviewees (#1, 2, 6-8) with a knowledge of Washington State, discussed both the State's emergency response procedures and the recent legislative bills that sought to lift the ban on planning for evacuation in anticipation of a nuclear incident. Interviewees noted that emergency managers in Washington State rely on an all-hazards preparedness plan rather than an incident specific model, as many emergencies have overlapping response procedures. Therefore, Washington State does not have a specific emergency plan in preparation of a nuclear attack or incident.

> *We as a state engage in all hazards preparedness, so we don't in general prepare for specific types of threats. We don't have a plan for nuclear weapons attack… We deal with our planning in an all hazards manner, with the understanding that preparation for one type of event will normally enable us to be successful in preparing for a different type of event… That all hazards preparedness helps us to use very, very scarce resources wisely.* (Interviewee #1)

> *Ever since 9/11, we've been preparing for any wide variety use of weapons of mass destruction. There were many urban communities including ours that took a good hard look at what it would look like if a dirty bomb went off in the middle of our city. So, we're aware of it. We've looked at it and we tend not to develop detailed incident specific plans because we'd never get out of the planning mode if we tried to do that. Instead we*

have all hazard planning that we do that says: how do we direct and control resources and share information and act with unity, effort, and intent… (Interviewee #2)

Interviewees (#1,2, 6-8) were split on their opinion of Senate Bill 5936 and House Bill 2214 that would lift the 1980s-era ban in Washington State on creating plans to evacuate or relocate people in advance of a possible nuclear attack.[33, 38,39] Interviewees #6 and 7 felt that at best the bills created conversation around the issue of nuclear weapons, but at worst the repeal could lead to a false sense of security. Interviewee #1 stated they would like to see the provision banning evacuation plans removed because they felt it was unnecessary, but that a change in legislation wouldn't equate to a change in planning.

The current law was a political statement to the federal government. So back in the late seventies or early eighties, the federal government said we're going to give you a grant funding to do an emergency management and planning, but we mandate that you do nuclear planning as a part of it. Washington and Oregon both said, I don't think we want to do nuclear planning. Thank you very much. We just want to do, our all-hazard planning, which is what most emergency management agencies do as a result. Washington, unlike Oregon, actually passed the law… That's just something on the books. It doesn't influence anything we do or don't do. (Interviewee #2)

I think that the best that could be said for this legislation is that it would provide a platform for talking about it and publicly debating it, and sort of forcing the issue. That it is possible, this could really happen to us, and we are not prepared for that possibility. I think at worst, it gives us a false sense of security to think that okay, well in some binder somewhere, there's a plan. Don't worry, we'll be okay… I think overall, it's potentially dangerous Bill, though well intentioned. (Interviewee #6)

Interviewee #7 also wondered what actively preparing for a nuclear event would signal to other countries.

There's also this interesting perspective of when you start, as a society, preparing for a nuclear attack or nuclear war, that signals to other countries that you are getting serious about military action.

Public education versus panic

In discussing preparedness measures, many respondents (#1, 5, 6, 8 and 9) described a tension between educating the public on nuclear preparedness and creating panic. Interviewees acknowledged that preparedness would have little effect in a nuclear war, but that nuclear preparedness knowledge could save lives in a smaller incident, such as with an IND.

> *I think the public should be better informed of how to respond in the event of a nuclear attack. First, to inform them that it's incredibly unlikely. Then if there is a nuclear attack, the best way for the average person to respond is to take shelter for 48 hours to two weeks, because the half-life of the radioactive elements in a nuclear weapon… actually decay very quickly. After 48 hours or so, something like 95 percent of the most deadly radioactive elements decay. And after two weeks, something like 99 percent have decayed. If you can go into a parking garage or basement… and wait for two days to two weeks, then your chances of survival greatly increase.* (Interviewee #5)

Interviewees did not provide strategies for educating the public on nuclear preparedness procedures. However, Interviewee #3 highlighted the national health guidelines of get inside, stay inside, stay tuned and stated that until the public was widely educated society would not be prepared.

> *Until the majority of people know and can bring to their mind the phrase: get inside, stay inside, stay tuned, which is what one must do or what one should do in the event of a nuclear attack. Until the public knows that as well as it knows, stop, drop and roll, I feel like we're not prepared.* (Interviewee #3)

Interviewees (#6, 7 and 9) raised ethical concerns about promoting a belief that people can widely survive a nuclear attack. Respondents indicated that realistic preparations were extremely limited.

> *But then I think you run into this really interesting, almost ideological question of should we as a society start preparing for nuclear war? Is that the right steps to take when really preparations are so limited... Should we instead focus all our efforts on preventing a nuclear attack from ever happening?* (Interviewee #6)

DISCUSSION

This study provides a glimpse into current perceptions held by professionals on the risks of nuclear weapons and responses. Interviewees expressed that nuclear weapons continue to be a cause for concern as they pose a risk by their very existence. The general perception of those interviewed is that there is a low risk of a nuclear detonation, but high consequence if it occurred. Interviewees stated the consequences of a nuclear weapon detonation today would depend greatly on the type, size, location, and number of weapons involved. The effect of any nuclear detonation would likely yield massive loss of life, destruction of infrastructure, damage to the environment, and place a strain on health and social systems. Interviewees felt that mitigation strategies, such as diplomacy, continue to be the best path for reducing the likelihood of a nuclear war. They further expressed that preparedness measures might only help in the event of a lower yield IND. However, interviewees felt a tension between educating the public on personal preparedness measures and inciting fear.

The concerns raised by the interviewees on the potential risk posed by terrorists are mirrored in the literature. Both Presidents Obama and Trump acknowledged the risks posed by terrorist groups in their respective Nuclear Posture Reviews, with many others also citing the need to secure nuclear materials and weapons.[5, 26] Additionally, disarmament may not entirely eliminate threat, given that the knowledge and materials to create nuclear devices still exist. These findings support the need for increased security around nuclear weapons and nuclear materials.

In response to increased global nuclear tensions, some countries and territories have initiated preparedness programs. Japan and Sweden have both encouraged their residents to

bolster their civil defense practices as there is growing fear of attack from nearby nuclear states.[20, 21] This supports statements made by interviewees who view the shift towards Cold War era preparedness measures as a "barometer for how scared the society is" (Interviewee #10). Preparedness measures in and of themselves do not seem to be increasing fears amongst the public. A stark exception is the false missile alert issued in Hawaii, which incited fear and panic.[23] The incident in Hawaii serves as an example of the inherent risks in preparedness systems, and supports the concerns raised by interviewees that a false alarm during periods of conflict could inadvertently cause a real nuclear weapon response.

A 1984 Washington State law banning the creation of plans to evacuate or relocate people in advance of a possible nuclear attack has recently received media attention in light of increased nuclear tensions and a push to repeal the ban during the 2018 legislative session.[33, 38, 39] Interviewees echoed public and political opinion on the 2018 bills and were divided in their feelings on the legislation. Champions for the bill cited the need to remove any restrictions on planning and resource allocation, while advocates for the original 1984 law expressed that repealing the ban could create a false sense of security.[40] Neither the interviewees nor the commenting public have expressed fears parallel to those that initiated original legislation.

Implications

Nuclear weapons pose a risk by their very existence. Though measures exist to mitigate this risk, only complete disarmament and elimination of nuclear weapons and materials will alleviate this risk. Until such time, nuclear states should continually improve security around nuclear weapons and systems. The international community, specifically nuclear-state actors, must work together to limit the availability of nuclear material or weapons to non-actor states.

With limited options for personal preparedness, individuals should continue to push their governments toward diplomatic measures against nuclear war and a commitment to global disarmament.

Public health professionals can educate the public on the risks related to nuclear weapons, possible personal safety protocols, and advocate for nuclear disarmament. In their role as educators, public health professionals should explain the unlikely nature of a nuclear detonation but the high and devastating effects should one occur. The national guidelines by the Center for Disease Control and Prevention (CDC) and the Department of Homeland Security state to 'get inside, stay inside, and stay tuned' in the event of a nuclear incident.[49, 50] They assert that an understanding of basic radiological preparedness steps could decrease the death rate amongst the public following a limited incident. [49, 50] Future research could focus on how to boost public awareness without causing panic.

Study Strengths and Limitations

The primary strength of this study is in the successful interviewing of respondents representing a variety of viewpoints around and knowledge of nuclear weapons, risks associated with nuclear weapons, disaster preparedness and response, and measures related to nuclear weapons. Interviewees had a breadth of experience and knowledge at local, regional, and national levels. Furthermore, they represented multiple backgrounds, including public health, environmental science, emergency response, security and policy, and government and non-governmental organizations.

The main limitation of this study is the inherent secrecy around nuclear weapons, particularly their storage and handling. Though some interviewees had backgrounds in

government or experience working in partnership with the government, none expressed a detailed working knowledge of potential risks related to nuclear weapon storage or handling. Though individuals and organizations representing diverse knowledge and expertise were approached, the use of purposive and snowball sampling may have unintentionally limited which potential interviewees were approached for participation, as it is a non-random sampling method.

CONCLUSION

Despite the fact that nuclear weapons have only been detonated twice in armed conflict, the sustained stockpiling and testing of nuclear weapons continues to pose significant humanitarian and health risks across the globe as well as locally in the Pacific Northwest.[45] To address these health risks, public health professionals can educate the public on the risks related to nuclear weapons and advocate for nuclear disarmament. Recent antagonistic rhetoric between nuclear state actors has renewed public concern, but sustained awareness and move towards action is necessary to create lasting change. On a global level, there is a need for increased diplomacy and respectful discussion amongst allied and adversarial nations. Through trust and partnership, nuclear-state actors could continue to shift the world towards disarmament further decreasing the nuclear stockpile and the risk of nuclear incident.

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Appendix A Abbreviations

CDC	Center for Disease Control and Prevention
CNTBT	Comprehensive Nuclear Test Ban Treaty, in 1996
DHS	Department of Homeland Security
FEMA	Federal Emergency Management Agency
IND	Improvised nuclear device
NPR	Nuclear Posture Review
NPT	Nonproliferation Treaty, first signed in 1968
PTBT	Partial Test Ban Treaty
SLCM	Submarine-launched cruise missile
UASI	Urban Area Security Initiative
UN	United Nations
USSR	Union of Soviet Socialist Republics
WHO	World Health Organization

Appendix B Consent Form

Researchers' statement: I am asking you to be in a research study. The purpose of this consent form is to give you the information you will need to help you decide whether to be in the study or not. Please read the form carefully. You may ask questions about the purpose of the research, what I would ask you to do, the possible risks and benefits, your rights as a volunteer, and anything else about the research or this form that is not clear. When I have answered all your questions, you can decide if you want to be in the study or not. This process is called "informed consent." I will give you a copy of this form for your records.

Purpose of the research: This descriptive study will explore the risks related to nuclear weapons in relation to suspected hazards from attack, accidental handling, and natural disaster. Research will be directed at understanding the current views of the likelihood and risk of each identified hazard, magnitude of potential nuclear attacks or accidents, and avenues to prevent or reduce impact in the event of a nuclear disaster.

What you will do in this research: If you decide to volunteer, you will be asked to participate in one interview. You will be asked several questions. Some of them will be about your views on the risks posed by nuclear weapons. Others will be about avenues to prevent or mitigate impact from a nuclear event. Notes will be taken during each interview. With your permission, I will audio record the interviews to minimize note taking during the interview, if a recording is taken it will only be used for transcribing notes and will be deleted once the thesis is complete.

Time required: The interview will take approximately 30 min to 45 min.

Risks: Our aim is to minimize any risk to you. Participation in the study and response to questions are completely voluntary and you can withdraw at any time without penalty. Any direct reference to you in the final thesis will receive your direct approval before submission as an attempt to mitigate any potential risk to you.

Benefits: Participation in this study is an opportunity for you to share your views and expertise with the greater public and help educate society on this topic. Participation in this study may not yield any direct benefits to you.

Confidentiality: Your responses to interview questions will be kept confidential and used only for the purpose of this study and used to inform and support this project's final thesis and thesis presentation. Any use of your name, identifying information, or direct quotes in the final thesis or thesis presentation will only be with your review and approval.

Participation and withdrawal: Your participation in this study is completely voluntary, and you may refuse to participate or withdraw from the study without penalty. You may withdraw by informing the researcher that you no longer wish to participate (no questions will be asked). You may skip any question during the interview but continue to participate in the rest of the study.

To Contact the Researcher: If you have questions, complaints, or concerns about this research, please contact: Christina DuJardin by phone at [number redacted] or email clavette@uw.edu . You may also contact the faculty member supervising this work: Aaron Katz, Principal Lecturer, School of Public Health, by phone [number redacted] or email garlyk@uw.edu.

Subject's statement: This study has been explained to me. I volunteer to take part in this research. I have had a chance to ask questions. If I have questions later about the research, or if I have been harmed by participating in this study, I can contact one of the researchers listed on the first page of this consent form. If I have questions about my rights as a research subject, I can call the Human Subjects Division at (206) 543-0098 or call collect at (206) 221-5940. I will receive a copy of this consent form.

Signature: _____ Date: _____
Name (print): _____

Appendix C Interview Questions

1. How would you describe the current social and/or political climate in relation to nuclear weapons?

    a. How does this differ or compare to other points in history?

2. Based on your opinion and experience in the field, can you explain why or to what extent you do or do not believe nuclear weapons pose a risk today?

Prompts: What about globally? locally? To what extent or magnitude?

3. Use of nuclear weapons is a common topic in the political sphere and increasingly so in social spheres. How likely is a nuclear attack in your professional opinion?

Prompts: What about globally? nationally? locally? when? What might prompt this event? How would it occur?

4. What are your thoughts on the possibility of a nuclear incident outside of a direct attack? (e.g. from accident, natural disaster, storage issues, etc.)

    a. Do strategies exist to prevent or minimize this accidental risk?

5. If a nuclear weapon attack or accident occurred today, what would the effects be on society?

    a. What if it occurred in the Pacific Northwest?

Prompts: What about globally? On infrastructure? On the population? On human health outcomes? Politically? Military?

6. What strategies exist to prevent a nuclear attack?

Prompts: What about globally? locally? What role might diplomacy play? How effective do you believe these strategies to be?

7. Do you know of any measures that other countries or cities have taken to prepare in the event of a nuclear event?

Prompts: If so, where and what? If not, do you feel that they should?

8. Thinking about Seattle and the Pacific Northwest, in what ways are we prepared or ill-prepared in the event of a nuclear weapon attack or accident?

Prompts: What is needed to mitigate or minimize these risks? What, if anything, should the public do to prepare? Should the public be notified in preparation for a nuclear attack or accident, and if so, in what ways?

9. Presently, Washington State has no official emergency plan in the event of nuclear incident, as state law prohibits its creation under RCW 38.52.030 of the Comprehensive emergency management plan. However, the 2018 Legislature is considering State Senate Bill 5936 and its companion House Bill 2214, which would lift the ban on 'creating plans to evacuate or relocate people in advance of a possible nuclear attack.'

a. What are your thoughts regarding both the current law and the proposed legislation?

10. Are you aware of any other jurisdictions that have specific legislation that addresses a nuclear event or preparedness related to a nuclear event?

11. Thank you for your time and participation in this interview, before we close, do you have any final comments or remarks on the topic of nuclear weapons?

12. As I continue my research, do you have a recommendation on who else I should talk to or key literature I should read?