Good morning, everyone.

Noon.

Welcome to the Yale Center on Climate Change and Health seminar.

I'm your host today, Dr. Kai Chan, assistant professor at the Yale school of public health.

During the presentation if you have any questions you can use the chat box and we will try to address them as the speaker finishes.

As a reminder, today's seminar will be recorded.

So, it is my great pleasure today to introduce our speaker professor Greg Wellenius from Boston university school of public health.

So Greg is actually the 2019 recipient of the ISEE Tony McMichael award.

So it is very exciting to have Greg here today because, everyone knows Tony McMichael was the pioneer that developed the connection between epidemiology and the global countries.

So with that legacy, I would like to take it over to Greg and very much looking forward to your talk.

Thank you, Kai.

Thanks so much for the invitation to speak here. And I only wish we could meet in person. Under better circumstances.

I was telling Kai before a few minutes earlier that one of the great pleasures of giving seminars in places is visiting with the people
0:01:26.14 -> 0:01:27.68 in small groups.
0:01:27.68 -> 0:01:31.21 So hopefully we’ll have the opportunity to do that,
0:01:31.21 -> 0:01:33.043 again shortly.
0:01:33.043 -> 0:01:34.343 So let me share my screen.
0:01:38.877 -> 0:01:39.71 Okay.
0:01:39.71 -> 0:01:41.9 So you should be able to see my slides,
0:01:41.9 -> 0:01:46.823 Kai, give me the thumbs up or somebody can see my
screen.
0:01:48.229 -> 0:01:49.062 Okay, great.
0:01:49.062 -> 0:01:50.82 So we’ll just go ahead and get started.
0:01:51.84 -> 0:01:54.19 So yeah, so feel free to stop me along the way.
0:01:55.065 -> 0:01:57.27 I will rely on Kai to flag me down
0:01:57.27 -> 0:01:59.95 if you wanna put questions in the chat window
0:01:59.95 -> 0:02:01.56 and then I can stop,
0:02:01.56 -> 0:02:02.75 I don’t mind being interrupted
0:02:02.75 -> 0:02:05.66 and that way we can make it more interactive that’s
fine.
0:02:05.66 -> 0:02:07.248 I should mention that,
0:02:07.248 -> 0:02:10.98 I am currently a visiting scientist
0:02:10.98 -> 0:02:13.95 working with Google and, this
0:02:17.105 -> 0:02:18.76 nothing I say here should be interpreted
0:02:18.76 -> 0:02:21.74 as being the official position of Google.
0:02:21.74 -> 0:02:22.941 All right.
0:02:22.941 -> 0:02:24.223 So with that I will get started.
0:02:25.661 -> 0:02:28.74 So I wanted to talk today about the effects
0:02:28.74 -> 0:02:32.04 of heat on health, which is,
0:02:32.04 -> 0:02:34.99 very well described in the scientific literature
0:02:34.99 -> 0:02:37.19 and connect that to
0:02:37.19 -> 0:02:40.84 why we have sort of this disconnect between,
0:02:40.84 -> 0:02:43.62 what we know about heat and the fact that
0:02:43.62 -> 0:02:48.62 people continue to die of a heat related illness.
0:02:48.86 -> 0:02:51.2 So the problem, as I see it is that excess heat
0:02:51.2 –> 0:02:54.27 is a widely recognized threat to public health.
0:02:54.27 –> 0:02:57.01 It’s often cited based on CDC statistics
0:02:57.01 –> 0:02:59.387 that in the U.S more people die
0:02:59.387 –> 0:03:00.47 of extreme heat each year
0:03:00.47 –> 0:03:02.93 than of any other meteorologic event.
0:03:02.93 –> 0:03:05.54 So despite all this knowledge,
0:03:05.54 –> 0:03:07.51 that we have about the risks of
0:03:08.9 –> 0:03:12.233 days of extreme and perhaps moderate heat,
0:03:12.233 –> 0:03:14.888 there seems to have been remarkably little progress
0:03:14.88 –> 0:03:16.93 towards preventing heat related illness and death.
0:03:16.93 –> 0:03:18.77 So we still see that heat waves
0:03:18.77 –> 0:03:21.906 are a major source of morbidity and mortality
0:03:21.906 –> 0:03:22.739 across the world.
0:03:22.739 –> 0:03:25.564 And so this got us thinking that
0:03:25.564 –> 0:03:26.95 this suggests a lack of translation
0:03:26.95 –> 0:03:29.62 of the abundance scientific knowledge about risks
0:03:29.62 –> 0:03:31.113 into public health action.
0:03:31.97 –> 0:03:34.77 And so just to highlight the point
0:03:34.77 –> 0:03:36.54 for those that may not be as familiar.
0:03:36.54 –> 0:03:41.024 So a Seminole study by Antonio Gasperini and colleagues,
0:03:41.024 –> 0:03:44.16 London school of hygiene, tropical medicine,
0:03:44.16 –> 0:03:45.25 published several years ago
0:03:45.25 –> 0:03:47.41 and have since published extensively,
0:03:47.41 –> 0:03:51.1 globally on the impacts of heat on health.
0:03:51.1 –> 0:03:54.82 And just to zoom in on a couple of locations,
0:03:54.82 –> 0:03:56.42 you could see that there’s this,
0:03:57.802 –> 0:03:59.302 U shaped relationship between,
0:04:00.992 –> 0:04:01.825 daily maximum temperature,
0:04:01.825 –> 0:04:04.44 is typically used and the relative risk of
0:04:04.44 –> 0:04:07.21 some adverse outcome in this case mortality.
And you can see that there is a temperature, what we’ll call the temperature of minimum mortality, or the optimal temperature at which the fewest number of people die. And then as temperatures get warmer than that, you see a sharp increase, in the relative risk of mortality and the shape of this curve, varies from location to location, but the pattern has been shown throughout the world by Gasperini and colleagues, as well as other groups in specific locations. So this is pretty universal and pretty well understood at this point. In the U.S we additionally know, about the effects on morbidity. So as measured by hospital admissions. So this is some terrific work done by Jennifer Bob working with Francesca Dominici at Harvard and team. And, so this was in the Medicare population looking at millions of hospital admissions for a number of different causes and showing both the relative risk and the risk difference of, hospital admissions for different causes that you can see. Increased relative risk of fluid and electrolyte disorders, renal conditions, urinary tract infections, heat stroke, and other external causes. And, with the risk difference shown there as well. So, interestingly although heatstroke
0:05:36.64 –> 0:05:38.1 has the biggest relative risk
0:05:38.1 –> 0:05:41.42 because it’s relatively uncommon as a diagnosis,
0:05:41.42 –> 0:05:45.24 the risk differences is smaller than for some other causes.
0:05:45.24 –> 0:05:46.59 So terrific work.
0:05:46.59 –> 0:05:47.83 So this is just a sampling.
0:05:47.83 –> 0:05:50.307 There’s a huge literature now on this,
0:05:50.307 –> 0:05:52.22 and very large studies demonstrating
0:05:52.22 –> 0:05:54.93 that extreme heat is associated with higher rates of death
0:05:54.93 –> 0:05:57.69 and hospitalization all across the world.
0:05:57.69 –> 0:06:02.12 Moderate heat is associated with higher rates of death, and,
0:06:02.12 –> 0:06:04.93 building amounts of evidence suggesting also
0:06:04.93 –> 0:06:06.363 with hospitalization.
0:06:06.363 –> 0:06:07.46 And we know that the vulnerability of these effects
0:06:10.27 –> 0:06:11.87 varies by personal housing
0:06:11.87 –> 0:06:13.959 and neighborhood characteristics.
0:06:13.959 –> 0:06:16.935 Further we know that the U.S has already warmed
0:06:16.935 –> 0:06:19.623 more than a degree and is projected
0:06:19.623 –> 0:06:21.02 to warm further through the end of the century
0:06:21.02 –> 0:06:23.617 in substantially with that,
0:06:23.617 –> 0:06:27.401 regional substantial regional variation and how much,
0:06:27.401 –> 0:06:29.733 further warming we expect to see.
0:06:30.97 –> 0:06:35.02 So how do we translate this into action
0:06:35.02 –> 0:06:38.67 that actually saves lives and reduces the health impact?
0:06:38.67 –> 0:06:40.64 So local public health and emergency
0:06:40.64 –> 0:06:42.54 preparedness officials
0:06:42.54 –> 0:06:43.89 need to know something a little bit different.
0:06:43.89 –> 0:06:46.117 They need to know what are the health risks
0:06:46.117 –> 0:06:49.41 associated with a given climate hazard in my location,
0:06:49.41 –> 0:06:51.52 what local actions can I take
0:06:51.52 –> 0:06:53.25 to protect the public health
and do these actions actually work?
So I’m gonna walk you through some of the research that we’ve done in this domain. And I’ll start with what are the health risks associated with a given climate hazard in a particular location?
So I started this work when I was in Rhode Island, actually Julia Gold at the time at the Rhode Island department of health, came to me and said, we really wanna know how many people are dying of heat and Rhode Island and how many ed visits, we need to know how to prioritize this. And I said, well, there’s lots of literature it’s a big problem you should just be worried about it. And she said, no, can you give me a number? And so I said, okay sure, let’s try to give a number. And then it turned out that New Hampshire and Maine were also interested in the same question. Public health officials in those States were interested in the same question. And because this was done at small, relatively smaller populations, we all had the challenge of having sufficient statistical power, to examine the associations between heat and either mortality or ed visits, in our own communities.
So we partnered with Rhode Island, New Hampshire and Maine to pull data, do the analysis in each of the community shown here and then pull the results to have enough statistical power.

And we also engage with the regional offices of the national weather service, in order, they were interested to reconsider the threshold criteria at which the heat advisories or heat warnings were issued based on local evidence. So we were trying to provide local actionable evidence, and in particular in communities outside of the large cities of the area that would otherwise dominate the signal.

And so we found what you’d expect is that the here we were interested in heat index ’cause we were doing this in partnership with the national weather service and heat index is this combination of temperature and humidity that they often use for issuing heat warnings and heat advisories.

And we found approximately what we expected, that there was a monotonic relationship between increasing maximum daily heat index and relative risk of emergency department admissions and deaths that you see there on the left and as you see there on the right. These were about of the expected magnitude.

And you can see that even pooling across these 15 locations, the confidence intervals around our estimates of,
0:09:30.042 –> 0:09:32.76 for mortality relative to some mortality
0:09:32.76 –> 0:09:34.86 were somewhat imprecise.
0:09:34.86 –> 0:09:39.69 So, the, I think the key part of this is,
0:09:39.69 –> 0:09:42.24 to translate sort of relative risks
0:09:42.24 –> 0:09:46.996 and smooth curves, which are available,
0:09:46.996 –> 0:09:49.321 with standard software now,
0:09:49.321 –> 0:09:54.321 thanks in large part to work by Gasperini and colleagues,
0:09:54.374 –> 0:09:57.11 is to translate that into real numbers.
0:09:57.11 –> 0:09:57.943 So, okay.
0:09:58.823 –> 0:10:02.03 So a curve is all good but how does that translate to
0:10:03.225 –> 0:10:07.33 number of excess ed visits or excess deaths
0:10:07.33 –> 0:10:11.264 attributable to days of different heat indices?
0:10:11.264 -> 0:10:13.83 So we created this table where the bottom row here
0:10:13.83 –> 0:10:16.86 shows you on all the days of 100 degrees
0:10:18.175 –> 0:10:19.76 with a heat index of 100 degrees or higher,
0:10:19.76 –> 0:10:24.526 excess CD visits were there on the same day, or,
0:10:24.526 –> 0:10:28.777 incorporating the lag effects up to seven days.
0:10:28.777 –> 0:10:31.35 And so, across these 15 new England towns,
0:10:31.35 –> 0:10:34.08 there were 39 additional ed visits
0:10:34.08 –> 0:10:37.133 on all days over 100 degrees and 232.
0:10:38.91 –> 0:10:41.79 If you incorporate the lag structure,
0:10:41.79 –> 0:10:43.663 the fact that the next day
0:10:43.663 –> 0:10:45.55 and the next day might also have some excess ed visits
0:10:45.55 –> 0:10:48.82 and about four to eight excess deaths
0:10:49.705 –> 0:10:52.2 for the days above 100 during this time period.
0:10:52.2 –> 0:10:55.49 And, obviously there’s more days that are at,
0:10:55.49 –> 0:10:57.01 or above 95 degrees.
0:10:57.01 –> 0:11:01.218 And so then, those numbers are bigger and, at,
0:11:01.218 –> 0:11:02.051 or above 95 degrees,
there's close to 200 to 700 depending on, how far out in the delay you want to incorporate, excess ed visits. So we took this information to the national weather service, to the regional office for the national weather service and said, look, we think that at temperatures below that, at which you currently issue heat advisories. So during this time heat advisories were issued by the national weather service for days with a heat index forecast to be above 100 degrees. We said, look at days as low as 95 or 90, we still see excess ed visits. And you can see that in the curves too, that, it's relatively monotonic so there's no reason to pick just 100 degrees as the threshold. It could be even at 95 degrees, you could, presumably warn or prevent some excess morbidity and mortality. And the national weather service said, okay that's great. And, so let me I'm gonna skip ahead to the national weather service. Okay, sorry. So before I get to the national weather service story, so 'cause I think that's really important, but then, so I want to shout out to Kate Weinberger, who was a postdoc in my group at the time. And what she said is, okay, this is great for New England, but how many people die of
0:12:24.359 –> 0:12:27.85 deaths attributable to heat across the country?
0:12:27.85 –> 0:12:32.09 And so using data that we had a mortality through
2006,
0:12:32.09 –> 0:12:37.09 she estimated that there were 5,000 or more excess
deaths
0:12:39.029 –> 0:12:41.65 per year across the U.S attributable to heat.
0:12:41.65 –> 0:12:43.28 This number is really important because
0:12:43.28 –> 0:12:45.41 it’s about an order of magnitude
0:12:45.41 –> 0:12:48.28 higher than what the CDC estimates
0:12:50.85 –> 0:12:54.29 report for heat related deaths that are those
0:12:54.29 –> 0:12:57.091 that are coded as being due to heat.
0:12:57.091 –> 0:12:58.52 And so when we think of sort of the,
0:12:58.52 –> 0:13:03.297 public health burden of disease of heat related illness,
0:13:03.297 –> 0:13:06.37 the CDC estimates, are important,
0:13:06.37 –> 0:13:08.64 but we think a likely an underestimate
0:13:08.64 –> 0:13:12.2 of the true excess mortality due to heat.
0:13:12.2 –> 0:13:14.529 The other important point here is
0:13:14.529 –> 0:13:17.68 that if we separate out the extreme heat days
0:13:17.68 –> 0:13:20.2 versus the moderate heat days,
0:13:20.2 –> 0:13:21.5 so we defined extreme heat
0:13:21.5 –> 0:13:23.96 as those days above the 95th percentile
0:13:23.96 –> 0:13:25.86 for a particular location.
0:13:25.86 –> 0:13:29.063 And these 297 counties across the U.S.
0:13:30.34 –> 0:13:33.53 The burden of disease is actually bigger for,
0:13:33.53 –> 0:13:35.33 deaths due to moderate heat.
0:13:35.33 –> 0:13:38.1 And that’s been reported previously,
0:13:38.1 –> 0:13:41.24 across the world and in the U.S but it,
0:13:41.24 –> 0:13:44.27 this puts concrete numbers on that that
0:13:44.27 –> 0:13:48.87 moderate heat accounts for a substantial burden of
disease.
0:13:48.87 –> 0:13:53.696 And the other key point from this study is that, the
risk,
The excess mortality is not distributed uniformly across the U.S. and there are parts of the country that seem much more vulnerable to heat-related mortality than others. Again, emphasizing the importance of local knowledge and local action to prevent these.

Okay, so let’s turn to local actions, that can be taken to protect the public’s health and evaluating if these actions actually work. In the U.S. the national weather service issues heat advisories and excess heat warnings when the heat index is forecast to be high. Now, and this is for most places, there’s a handful of places that use the other criteria besides heat index. But these warnings that are issued provide information that the public can take, and in some places the warnings may also trigger activation of local heat response plans that may involve things like opening cooling centers, or reaching out to particularly vulnerable communities in addition to targeted messaging. These heat advisories or heat warnings remain largely unknown or unstudied.

So based on the work we did in that New England study,
working with the national weather service regional office,
they decided to partition the Northeast, which was,
had one criteria for issuing heat advisories
prior to this work starting in summer 2017,
they changed it so that the,
new way in New England was treated separately
from the rest of the Northeast,
acknowledging that the vulnerability
to a heat related illness might be different in New England,
not just based on our study,
there’s other studies that have shown that as well.
So this felt like a major public health victory.
So following this starting of the summer of 2017,
the national weather service in the region,
issued heat advisories when the heat index
was forecast to be greater than 95 degrees.
There was some confusion as to whether
that should be for one day or for two days,
it was initially for two days.
And, then they subsequently revised the criteria,
to be consistent across the New England region.
So essentially changing the heat advisory threshold
from 100 degrees heat index to 95 degrees heat index.
So this felt like, to me,
this was, one study,
one paper that, and a series of conversations
that ended up changing the criteria,
at which heat advisories are issued for,
a region with a substantial population.
So that felt very impactful,
but it leads to the question of okay, so we’re issuing more heat advisories now than we were before, because we’ve changed the threshold. Does that actually save anybody’s life? So, we weren’t the first or the only ones to be having this type of conversation. We followed in that research some very nice work, from New York city, where they also informed local policy through evaluation of data in New York city. And so the question we were asking is, what is the optimal threshold for issuing heat alerts, heat warnings, and heat advisories. But these conversations assume that issuing heat advisories and warnings actually reduces heat-related morbidity and mortality. And there’s been relatively few studies on that question. What, again, there’s a handful of studies, but one that I particularly like is this study from, Tarik Benmarhina while he was still at McGill and looking, taking a very creative approach to looking at the effectiveness of the heat action plan that including a new heat early warning system on, heat related mortality in Montreal. And, that team reported that the having this heat action plan implemented in Montreal, reduced mortality during hot days by about two and a half deaths per day, and with particularly larger effects amongst the elderly.
So we wanted that’s exactly the question we wanted to ask is the issuing of heat warnings, heat early warning system. How much does that benefit the population? So we built this study on the advantage that heat warnings are issued by people, and they’re issued on forecasts. They’re not completely algorithmic. They are issued by specialists at the national weather service that are focused on heat warnings. And, they, there’s a collection of days where we forecast that there will be a high degree of heat. And then it turns out to be a little bit less, and then there’s other days where we forecast, lower heat levels. And it turns out to be a little bit higher. So the forecast can be wrong even just a little bit. And because they’re issued by people, there’s some discretion in how much they think people need to know about the upcoming heat. So for instance, we were told that on the 4th of July, you might issue a heat alert at a slightly lower, forecast heat index, then on another day, because so many people are gonna be outside. So many people are going to be exposed that maybe, we can have the flexibility to change that threshold. And that was entirely built into the system. So there should be these days with a similar heat index, right around sort of the warning threshold,
some of which have a heat warning some of which do not.

And so that’s the paradigm we were taking advantage of.

And at the time we had data on heat warnings from 20 cities that issue heat warnings regularly.

And, we matched us to the mortality data we had from the CDC.

So the overlap between these two data sets is 2001 to 2006.

And, again, comparing days of similar heat index, with versus without a heat alert, this is the relative risk of mortality, associated with having a heat alert.

And so if he’d warnings or heat advisories were protective of the population, you would expect to see a decreased relative risk or a decrease in the rate of mortality on days with a heat alert compared to without.

So interestingly, we did not see that across these 20 cities, overall there was a null association.

And the one place where we did see an association was, Philadelphia with a reduction of about 4% in mortality of about 4% on days with a heat warning versus without.

So this could be for a couple of reasons.

One Philadelphia, we know has been very proactive about having a robust heat early warning system and taking action on days expected to have high mortality.
It could also be that this was 20 estimates, and that one out of 20 was, in the direction that we expected. So clearly needs a followup study, but then we played the thought experiment of so heat alerts were effective at reducing mortality in Philadelphia. And the number of deaths we estimated, that were averted in Philadelphia each time they issued a heat alert, was about four and a half or five lives per time. And so if you extrapolate that to the typical year in Philadelphia during this time, that meant that the heat early warning system saved about 45 lives per year. Again, lots of assumptions of causality, but it gives us a starting point that if the heat warnings could be as effective as they were observed to be in Philadelphia during this time then a city like New York, or Dallas or Phoenix, could potentially save quite a few lives per year, depending on the effectiveness of the heat warning and how often the heat alerts are issued per year. So this provides, a rough for back of the envelope calculation as to how many lives could potentially be averted each year, across the country if heat warnings, reduced, mortality by the same magnitude as we saw in Philadelphia. Okay.
And, again, I want to emphasize that we’re not the only ones that have considered this question. This is some great work by Kristie Ebi 15 years earlier, showing that in Philadelphia, exactly. The heat warning system, she estimated, each time that a heat warning was activated saved two and a half lives per day. So, in the same ballpark of the estimates, we were seeing but in a very different time period. Okay, so there’s lots of limitations to this study. One of them is that the data we were using at the time was old, was mortality data through 2006. So, Kate Weinberger has since been updating this, sorta with more recent mortality data from, nine Northeastern cities where we found the data readily available in collaboration with Joel Schwartz and team. And, there, we, she found, that perhaps, 3% mortality benefit on heat warning days versus, days with versus without heat warnings. So maybe it’s just that in 2006 and earlier, when most places did not yet have a heat action plan, then, we don’t see very much of a benefit, but in more recent times where, many more communities do have heat action plans, tied to those heat alerts that we see, perhaps some signals so we’re following that up in a broader population. And then the other question is of course,
is that mortality is not the only outcome of interest that,
we also want to prevent illness,
as reflected through hospitalizations.
And, here we saw in 97 counties in 2007 to 2012,
using Medicare hospital admission data. We found no reduction in the risk of emergency hospitalization during this time point.
So again, to works in progress that, we’re following up on a larger scale and with more recent data.
Okay, so our national weather service heat warnings effective, they may reduce the risk of death in some cities, but we don’t yet see evidence of widespread health benefits.
And if that’s true and again it needs to be confirmed, that would represent a missed opportunity to prevent heat-related morbidity and mortality.
There’s lots of limitations to the analysis I’ve shown here, and we’re working to actively to address these limitations.
So I just wanna emphasize the, that we’re at the beginning of the road here not the end.
Okay, so I wanna turn to talking about, how susceptibility to heat related illness might vary by age groups.
And, so in one of the first studies we did in Rhode Island,
we looked at emergency department visits, to Rhode Island over several years now, there’s only a million people in Rhode Island. So again, there’s an issue about statistical power. But the interesting thing is that, of course, we all think of the elderly as really vulnerable. And what we saw is that for heat related ed visits, in fact, the relative risk was a lot higher, so this is excess relative risk. So these are percents. So this would be an odds ratio of 1.6, approximately. So that the relative risk was actually higher in that study for population of adults of non elderly adults, 18 to 64 and with significant for kids also or children and adolescents 18 and under, so what to follow that up. More recently we partnered with Ari Bernstein, the Harvard, center for climate health and the global environment, and using data from on ed visits from a network of standalone U.S children’s hospitals. These are 47 hospitals and the recent Tara with a total of three point million ed visits, amongst children and adolescents. And you can see the location of the hospital here and so a little bit hard to see here, but what we see is that the overall relationship between, maximum daily temperature and the relative risk of ed visits for all causes in this population is a 1.17 or about a 17% increase.
And for heat related illness it’s about a relative risk of 1.83.
And again, you see it’s interesting for all cause ED visits, there’s not a lot of heterogeneity by age, but there does seem for heat related illness specifically seem to be somewhat of a stronger effect amongst the older adolescents.
So that was really interesting.
And then we wanted to sort of move beyond heat related illness to look at a number of potential causes.
And this is a little bit hard to see. So I just wanna zoom in a little bit.
So to the, we considered a number of different categories of disease, some of them that we sort of had prior hypotheses for, and some that seemed like we should just check.
And these are adjusted for multiple comparisons in this sort of more agnostic analysis. And you can see that heat related illness of course comes up with a very high relative risk, but there’s other interesting and much less explored associations between different causes of ED visits in children and adolescents and temperature. So, more to be done there,
we’re quite excited by these results. I’ll make the point as in the paper I showed you at the beginning by Jennifer Bob and colleagues that not all the conditions with the highest relative risk
don’t always have the biggest sort of numeric impact.

So heat related illness here,
you see the attributable fraction.
So of the heat related illness
a substantial proportion are due to heat.
And, but heat related illnesses
and in frequent or uncommon diagnosis.
And so the out of 100,000 ed visits,
it contributes a relatively small proportion.
Whereas for injury and poisonings are very,
very common diagnosis amongst kids, as,
so even though the attributable fraction
is smaller for them the attributable number
per 100,00 ed visits total
is much bigger because it’s much common.
Okay, so I wanna share with you some,
very exciting work that Darren Son in my group is,
leading and working on.
So this is now turning to 18 to 64 year old individuals.
And this is amongst an insured population,
working with data from the Optum labs.
And obviously here you have the number of sorry,
the average summer maximum temperature.
And then this just shows you sort of the distribution
of where we have information on in this population.
So it tends to follow,
the distribution of population
focused on obviously more urban locations.
But, this particular data set has a more info
tends to have more information in the Southeast
and in the Southwest.
And, you can see here is that overall there’s a relative risk of ed visits, amongst these non elderly adults an odds ratio of 1.1, let’s say about a 9% increase in risk and for heat related illness it’s a relative risk of about 1.9. And again, you see some variation in, the relative risk by age, some heterogeneity by age that we’ll explore a little bit further to see. It’s interesting though that sort of repeatedly we’re seeing that although elderly are known to be, and there’s good evidence that they are a susceptible subgroup, that’s by no means the only part of the age distribution, where we have sensitivities and in there’s we know of from other studies, outdoor workers, children that spend a lot of time outside, perhaps children’s spending time in non-air conditioned schools, can also be quite a bit at risk. Okay. So turning back to the, the bigger, framework. So on a global and national scale we think that we understand the adverse health impacts of heat. But there’s been this lack of translation of abundance scientific knowledge on the risks and to public health action in terms of prevention. And so, again, this means that there’s insufficient evidence
0:32:34.69 –> 0:32:36.2 to guide the public health response
0:32:36.2 –> 0:32:38.423 to present day or future heat.
0:32:39.32 –> 0:32:44.32 If we were designing, optimal response to heat,
0:32:44.37 –> 0:32:47.59 Jeremy Hess and Kristie Ebi have written nicely about this,
0:32:47.59 –> 0:32:50.42 you’d define dangerously hot weather,
0:32:50.42 –> 0:32:52 you’d forecast it well,
0:32:52 –> 0:32:54.67 you’d identify who’s at greatest risk of these effects.
0:32:54.67 –> 0:32:57.85 You’d intervene to reduce those health impacts,
0:32:57.85 –> 0:33:00.65 and you’d evaluate the effectiveness of those interventions.
0:33:00.65 –> 0:33:02.59 And you do this on a continuous cycle.
0:33:02.59 –> 0:33:06.423 You’d do this repeatedly to continue to optimize.
0:33:07.307 –> 0:33:10.71 So, our broader research agenda
0:33:10.71 –> 0:33:14.21 follows mirrors these image.
0:33:14.21 –> 0:33:16.591 So, the vision that we have is that
0:33:16.591 –> 0:33:19.19 we could provide the evidence needed for any community
0:33:19.19 –> 0:33:22.08 in the U.S to mitigate the adverse health impacts
0:33:22.08 –> 0:33:23.32 of extreme heat.
0:33:23.32 –> 0:33:25.826 And I’d probably amend that now to say
0:33:25.826 –> 0:33:27.572 both extreme and moderate heat,
0:33:27.572 –> 0:33:28.732 although we recognize
0:33:28.732 –> 0:33:30.4 that they require different strategies,
0:33:30.4 –> 0:33:33.37 the same strategies won’t be effective for both,
0:33:33.37 –> 0:33:36.228 thinking about moderate and extreme heat.
0:33:36.228 –> 0:33:38.9 The concrete sort of next steps in that is
0:33:38.9 –> 0:33:41.45 to identify optimal health based and location
0:33:41.45 –> 0:33:44.27 specific metrics for issuing heat alerts.
0:33:44.27 –> 0:33:49.27 We wanna follow up our work on the benefits of
0:33:49.36 –> 0:33:53.46 heat alert’s heat warnings and heat advisories,
0:33:53.46 –> 0:33:54.646 because I think there’s
they’re probably effective in some circumstances in some places and in some populations. And if we knew where they are effective and under what conditions, then we can presumably provide information that helps other communities replicate that effectiveness. I think there’s a lot of potential benefit, to investigating that further. And you, one of the shortcomings in this line of research is that we don’t actually have a centralized database of which, what local health departments are, what actions local health departments are taking in response and preparation for, and in response to days of extreme heat. And so one of our goals is to try to catalog that we’re working with Jeremy has and Nicole era, at university of Washington. And then if we can identify again, the key elements of these interventions and where they’re most effective, then we can share this information back with local health departments and say “hey, if you have limited resources and you, here’s what has worked in other settings “that are similar to your settings “in terms of whatever characteristics, we wanna have about the community. Okay, so I wanna acknowledge also that, heat doesn’t happen alone.
This is some great work done by Keith Spangler, who is currently a post-doc in working in my group. And this was part of his doctoral dissertation at Brown. And what you see here is different hazards across different parts of New England, sorry. So, this is a probability of one or more days with the heat index above 95 degrees. And so you could see the distribution of that. So there’s parts of New England that are more prone to getting really hot days. The distribution of getting an inch or more of rainfall is quite different. And similarly, the distribution of the risk of high ozone days is again different. And we don’t have high PM 2.5 levels in New England. But, if you were to look at where they are highest, you can see the distribution again is quite different. And so if you integrate those into the percent of days with one or more hazards during this time period, you see that there’s an interesting distribution where parts of the Connecticut river Valley and Southern Connecticut are particularly high risk of being exposed to one or more hazards. Interestingly, if you connect this with the social vulnerability index, this is the CDC social vulnerability index that is also not homogeneously distributed. And interestingly, those high vulnerability locations, also tend to have a higher probability of having more than one hazard.
This is primarily driven by the distribution of the hazard of excess heat, and somewhat by the excess ozone. So really interesting to think about how the hazards overlap with each other and with social vulnerability. Keith created a climate risk index based on this which looks different depending on the spatial scale that you look at.

So again, if you combine the hazards and the social vulnerability, again, the Connecticut river Valley at Southern Connecticut, coastal Connecticut show up as places of particularly potential pretty high impact. And if you were to look instead at the Boston metropolitan area here, you can see that on a very fine spatial scale. There’s tremendous heterogeneity as well in this.

Okay, so to close. So in order to adapt to current and future climate hazards, local officials need to know what’s the current health risk associated with a given hazard, what local actions can be taken to protect the public health. Do these actions actually reduce the risk of the hazard? How has the risk likely to change into the future? I didn’t go into that today, but obviously we have very good projections of future temperature changes under different concentration pathways, so we can predict into the future.
under different potential alternative realities.
And we can do this in a repetitive way
to continue to optimize.
And so this just Zooming way out,
highlights the needs and challenges
of translating scientific research
into public health benefits.
So, this none of this would be possible
without a fantastic team local team in my group,
as well as, fantastic collaborators.
Kate Weinberger was a former post-doctoral fellow
that worked with me and is now
at the university of British Columbia.
We have a terrific team at Boston university and formerly,
people were still connected with at Brown
and then fantastic collaborators at Harvard,
university of Michigan,
university of Washington and Mount Sinai.
And of course we all need funding,
and I’m very grateful to the funding from NHS
and Wellcome trust.
So I will stop there and a welcome your questions.
- Great, thanks, Greg, for the very, insightful presentation
and also sharing with us your latest research.
Before we go to the question from the attendees,
we actually, have already pre collected questions
from the our students who attend the
Climate Change and Health seminar.
I’m happy to see actually doing your presentation.
A lot of questions has been answered.
So just, pick some of the questions remaining. One the heat topic that the students are wondering is about the effectiveness of the heat index system. So they’re wondering, like why there’s no standard index in different places, and why there can be some, action of, why there can be some other matrix that can be considered like the wet bulb temperature, which may shows, more spatial rate disperse, varied effect rather than that or temperature. Yeah, it’s a great question. So the national weather service sets up, actually the national level of the national weather service makes recommendations of criteria that could be used, to issue heat alerts and then encourages regional offices and even local offices to come up with their own criteria that, are most appropriate for the populations that they serve. And so there isn’t exact, it’s not, a top-down sort of you must use this, here’s a standardized threshold, which, some countries have taken that approach. This is a much more decentralized approach. So many, many, locations do use the heat index. And for approximately, Northern location sort of Northern half of the country uses a heat index of 105 as a threshold for issuing heat warnings and, a threshold of 100 degrees heat index for issuing, heat advisories,
and then the Southern half of the country, approximately,

each of those is five degrees set at five degrees higher,

but there’s a number of locations,

they use their own system, including,

Philadelphia is notable for using

a predictive model of sort of how many people are at risk from this heat.

New York city has done some terrific work on,

changing the threshold.

So there a number of examples around the country where,

local health departments have worked with the community
to identify what’s the most appropriate metric and threshold for issuing heat alerts.

But the challenge with that approach is that,
it’s not a systematic investigation

it’s not a systematic investigation

of what would be work the best.

So one of our goals is to think of,

well, let’s look everywhere in the country

and see what either by region or by community

or by climate zones,

what would be the optimal metric for predicting,

which are the most dangerous days of extreme heat,

keeping in mind that it’s in nobody’s interest to issue,

a very high number of heat alerts each year.

So you really wanna focus each summer on like,

what are going to be the worst days,

how do we identify those

and sort of using a health based perspective

rather than a weather based perspective?
So it’s not necessarily the hottest days, but rather, we know from the work of others that, the, vulnerability to heat varies by location, by population and by time of year, as well as it’s been shifting over the years. And so taking all that into consideration, can we sort of have a health based metric for issuing heat alerts heat warnings, and heat advisory’s. Wet bulb globe temperature is a really interesting one. There’s, I think that it’s potentially very interesting, and I know that in some occupational settings, a wet bulb globe temperature is used as the guiding metric. It has not been to my knowledge been widely used, in sort of population level, heat warning work. But I think it’d be really interesting to look at that as well. Great, thanks. Another kind of very detailed technical question is one students is wondering, the previous paper, where you choose the control days, because if you have a very higher threshold, then it’s likely that you don’t have enough control days. - That’s a great question. So this refers I believe to Kate’s study of looking at the effectiveness of heat warnings. And so what we did is we compare days,
0:44:45.83 –> 0:44:48.22 of the similar heat index
0:44:48.22 –> 0:44:50.43 and with or without a heat warning.
0:44:50.43 –> 0:44:53.615 And you're right, that for very hot days,
0:44:53.615 –> 0:44:55.073 like if a day is 110 degrees, heat index,
0:44:55.073 –> 0:44:57.81 that there's not going to be any days
0:44:57.81 –> 0:45:00.48 in that same location of 110 degrees,
0:45:00.48 –> 0:45:02.52 that didn't have a heat warning.
0:45:02.52 –> 0:45:07.52 So, by so we had to limit ourselves to those days in
which,
0:45:09.09 –> 0:45:12.95 we sometimes saw a heat warning but not always.
0:45:12.95 –> 0:45:16.174 And if, a 90 degree day,
0:45:16.174 –> 0:45:19.401 nobody's issuing heat alerts and on 110 degree day,
0:45:19.401 –> 0:45:20.234 everybody's issuing heat alerts.
0:45:20.234 –> 0:45:22.11 And so we had to focus on the middle.
0:45:22.11 –> 0:45:24.86 So one of the limitations of this work is that
0:45:24.86 –> 0:45:27.779 it is there's no counterfactual,
0:45:27.779 –> 0:45:30.95 there's no information about the counterfactual of like,
0:45:30.95 –> 0:45:33.45 what would have happened had we not issued a heat
alert
0:45:33.45 –> 0:45:34.6 on a very, very hot day?
0:45:34.6 –> 0:45:38.17 There's just, there's no data is conditional on location.
0:45:38.17 –> 0:45:39.93 So that is one of the challenges.
0:45:39.93 –> 0:45:42.29 So we should, our results are generalizable
0:45:42.29 –> 0:45:44.74 to those days on which you might,
0:45:44.74 –> 0:45:46.71 or sometimes issue heat alerts.
0:45:46.71 –> 0:45:51.3 And not outside of that relatively narrow band
0:45:51.3 –> 0:45:52.203 of temperatures.
0:45:53.62 –> 0:45:54.75 - Thanks.
0:45:54.75 –> 0:45:59.642 I think we do have a question from the audience,
0:45:59.642 –> 0:46:01.757 one of the first, so,
0:46:01.757 –> 0:46:06.19 the question from Stephan Lessen is asking
0:46:06.19 –> 0:46:09.11 about one third of the Medicaid population
has no access to the internet.

So how, the heat alerts commonly distributed within cities.

- Yeah, that’s a really great question.

And again, it varies a little bit by location.

The several or many of the national weather service, local offices are actually on social media now, and you,

you could follow them on Twitter, there’s, also,

can sign up for their email newsletters,

that’ll warn you of particular, threats,

and you’re right that those channels,

while they might reach some segments of the population,

they, probably are focused on those segments of the population

that are particularly engaged

and maybe not particularly at risk,

for heat specifically.

So, traditionally this was all through TV and radio,

where you would say, national weather service has

issued a heat alert for the next two days, or for,

this region for tomorrow and advises you to,

drink lots of water avoid exposing yourself to

your kids to high heat, et cetera.

So I think they use a combination of traditional

and digital media, channels,

but I think it raises a good question of,

are we reaching the most vulnerable populations,

with these alerts?

And even if we inform people that there’s a risk

that doesn’t necessarily mean that people are able,

to protect themselves from that risk.
So for instance when we think of the most vulnerable populations, you’re amongst them sort of perhaps outdoor workers, so outdoor workers, there are guidelines in temperatures above which outdoor workers shouldn’t work, but your roofers and landscapers and construction workers, they’re not getting paid if they’re not doing the work. So sort of the opportunity for not just reaching and informing people, but actually giving them options of how to protect themselves, is I think a really hard challenge. You see this also with agricultural workers and other settings. So I think that we have to move from a model where we’re just trying to reach people to give them information to discovering, understanding and addressing the hurdles to actually protecting themselves, rather than just a deficit model. Yeah thanks. I think, kind of follow up on these detailed questions one of the students is asking like, behind this (indistinct) system exactly. Kind of mixture of all multiple different intervention, matters such as you said, some including TV, some including other informing approaches. So, kind of further question is how to evaluate the cost and effectiveness
of different approaches when people, when
the public health officials want to inform,
want to intervene.
- Yeah, I think it’s a really interesting question.
And so there’s two questions.
There is sort of what,
how do you evaluate the effectiveness
of these different channels?
And I think the broader question is,
can we move away from thinking that
a channel of communication or a series
works on the population as a whole?
So, for example, if we,
if you wanna try to reach and protect outdoor workers,
there’s probably channels of communication
and engagement that are different
than if you’re concerned about seniors
in institutional facilities,
or if you’re thinking about kids in school
based environments or summer camp environments.
So I think we probably in our communication strategies
and engagement strategies need to move away
from thinking that if only we use channel X,
we’ll reach more people,
it’s not about reaching more people,
it’s about reaching specific segments of the population
in specific ways that are amenable to their needs
and the resources available to them.
So I think working with school nurses is a great way
to reach kids in school.
I think working with organized kids activities
is a great way to reach again, vulnerable children and adolescents. But those strategies aren’t gonna work in other settings. So I think it has to be much more targeted than we’re doing now. Thanks, yes, those words are insightful. I do have another question from the audience, from Alexi, is asking, is there evidence of political inference determining the implementation of the warning system? It’s a great question. I actually don’t know enough to, so I haven’t seen political influence in that, but, I haven’t worked with, too many national weather service offices directly. So I think there’s probably others involved that can answer that more. One of the interesting linkages is that sort of the whether these heat alerts trigger local action varies across locations. So in New York city, I understand that every time the national weather service issues a heat warning, that triggers a certain number of activities. Like there’s no intermediate decision, whereas in the city of Boston I understand that it’s when the mayor declares a heat emergency, which is informed by the national weather service forecast and heat warnings, but it’s not automatically triggered by. So I think there’s some differences in,
or quite a bit of differences actually around the country as to whether the national weather service heat alerts automatically trigger action, or are they informational, but the action is triggered by some other mechanism. And that’s one of the things that we need to get a better handle on across the country is this the right trigger for local heat action plans to, and heat responds plans to be activated. And, I don’t have a preconceived notion as to what the right answer there is. Maybe this is the optimal trigger or maybe something that it’s appropriate to have an intermediate step of somebody else sort of making a judgment call for that local population. So I think that’s an exciting area of research.

We do have another question from, Rob Tuber. He’s asking, have you ever looked into the effectiveness of cooling centers? I love cooling centers because they seem like such a great idea. Oh, people are know dying or or being hurt by heat let’s provide them a cool place to go. And the anecdotal evidence is that, you open cooling centers and very few people go. And so again, understanding the hurdles of that. I’ve worked somewhat with people in New York city and I understand that they provide
transportation assistance for vulnerable populations,

because I think one of the hurdles they found was that,

not everybody can get themselves to a cooling center,

so you opened a cooling center and that assumes that

somebody can go.

Okay, so there’s cultural barriers to or

barriers in terms of like, well,

what am I going to do there?

Is this a place where I’m actually welcome?

How do I get there?

Can I actually afford, like,

if I work, again,

can I take the time to go do that?

Or if I have, medication needs will I be able to,

treat my medical condition while I’m there?

So I think that cooling centers are really

intuitively attractive option.

And I think with so much of what we do in response

to heat,

there is not a body of evidence as to what works.

And I think that’s really where we need to

sort of move the field is starting to think

about what works in what settings and for whom,

so that we can really provide evidence-based guidance

for developing solutions.

Thanks very well said.

We do need a lot of these evidence-based research

on these policy actions.

I do have another follow-up question from the students,

is that actually within your next steps?

So the students is kind of wondering
0:54:54.34 –> 0:54:58.66 how do you actually verify the causal assumption
0:54:58.66 –> 0:55:01.537 in evaluating the heater systems?
0:55:02.77 –> 0:55:04.21 - Yeah, that’s great.
0:55:04.21 –> 0:55:09.21 So, the best we can do is use the data,
0:55:11.81 –> 0:55:14.3 this isn’t a randomized, these aren’t randomized studies.
0:55:14.3 –> 0:55:15.993 So the best we can do is,
0:55:16.84 –> 0:55:19.82 use observational data to the best of our ability.
0:55:19.82 –> 0:55:22.69 So, can we ever prove that we understand
0:55:22.69 –> 0:55:24.06 the causal effect of heat alerts?
0:55:24.06 –> 0:55:26.854 No, but I think we can do,
0:55:26.854 –> 0:55:31.73 more detailed, more insightful analysis
0:55:31.73 –> 0:55:33.78 of the existing observational data.
0:55:33.78 –> 0:55:38.78 And I think this idea of there are a range of days.
0:55:38.85 –> 0:55:40.79 So going back to the heat warnings,
0:55:40.79 –> 0:55:42.17 there’s these days where we say,
0:55:42.17 –> 0:55:44.475 we’re always going to issue a heat warning,
0:55:44.475 –> 0:55:46.44 ’cause it’s just so hot that we just take it for granted
0:55:46.44 –> 0:55:49.354 that it’s dangerous and we need to do something,
0:55:49.354 –> 0:55:50.454 so we’re going to do it.
0:55:50.454 –> 0:55:52.314 And then there’s this other bucket,
0:55:52.314 –> 0:55:55.219 a days on the other end where like, it’s just,
0:55:55.219 –> 0:55:57.29 issuing key warnings is just not likely to be effective,
0:55:57.29 –> 0:55:59.2 but there’s this middle range where you’re like,
0:55:59.2 –> 0:56:00.61 should I issue a heat warning?
0:56:00.61 –> 0:56:01.89 Yes or no.
0:56:01.89 –> 0:56:04.61 And so what we’re doing is providing information
0:56:04.61 –> 0:56:07.323 on that part, the spectrum, and where we say,
0:56:08.89 –> 0:56:11.468 should we issue somewhat more heat alerts
0:56:11.468 –> 0:56:13.99 because we can do it right around this threshold,
0:56:13.99 –> 0:56:15.51 would that save lives?
0:56:15.51 –> 0:56:20.23 And, that’s it’s not the entire picture.
It would be so interesting to know on these very hot days when we issue heat warnings, do they actually prevent deaths? And the problem is as we said before, that there’s no data on the counterfactual, like what would have happened had you not issued a heat alert? So, there’s probably other creative ways to do it, but we haven’t figured that out yet. So this is really about at the margin, would you do better issuing say 10% more heat alerts each year, or 15% more heat alerts each year? 'Cause you don’t wanna issue them if they’re not, there’s risks of warning, fatigue of people not taking it seriously. Because there are too often and there’s some costs associated with each time you issue it, if it triggers actions. So it’s again, it’s like, no, should we issue a few more? And in that question, we, so far our evidence suggests that there’s not widespread benefit of them, but, sort of with the asterisk that more work is needed on that.

Okay, thanks, yeah. I think we have the final comment or question. I’ve been struggling to see how implementation science might promote environmental health. This project is a perfect example of the connection.
0:57:41.153 -> 0:57:42.123 - Thanks Donna.
0:57:43.062 -> 0:57:44.23 I think that’s a great point.
0:57:44.23 -> 0:57:46.94 And I think that there I have not seen a large amount on implementation science,
0:57:46.94 -> 0:57:48.4 on specifically oriented towards solutions
0:57:48.4 -> 0:57:52 in environmental health.
0:57:53.31 -> 0:57:55.78 We’re really great at describing problems
0:57:55.78 -> 0:57:57.51 and less good at figuring out and implementing solutions
0:58:02.844 -> 0:58:04.525 and then evaluating their effectiveness.
0:58:04.525 -> 0:58:06.702 So I think that this is right for that
0:58:06.702 -> 0:58:07.97 because we know there’s a risk there.
0:58:07.97 -> 0:58:10.689 We just don’t actually know exactly what to do about it.
0:58:10.689 -> 0:58:12.43 And there are lots of good ideas,
0:58:12.43 -> 0:58:15.007 but we need to move from good ideas to,
0:58:15.007 -> 0:58:17.823 good evidence supporting specific ideas.
0:58:20.093 -> 0:58:20.968 - Great.
0:58:20.968 -> 0:58:24.57 I think with that we will conclude, this seminar
0:58:24.57 -> 0:58:27.48 and thank you Greg, for this wonderful presentation
0:58:27.48 -> 0:58:30.13 on the science-based actions.
0:58:30.13 -> 0:58:34.32 And, this seminar will be recorded
0:58:34.32 -> 0:58:36.54 and will be posted later.
0:58:36.54 -> 0:58:40.2 So thank you all for coming and thanks again Greg.
0:58:40.2 -> 0:58:42.44 - Wonderful thanks for the opportunity, bye bye.
0:58:42.44 -> 0:58:43.273 - Bye.