Good morning, everyone.

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.

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.

Wonderful.

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 in small groups. So hopefully we'll have the opportunity to do that, again shortly. So let me share my screen. Okay, great. So you should be able to see my slides, Kai, give me the thumbs up or somebody can see my screen. Okay, great. So we'll just go ahead and get started. So yeah, so feel free to stop me along the way. I will rely on Kai to flag me down if you wanna put questions in the chat window and then I can stop, I don’t mind being interrupted and that way we can make it more interactive that’s fine. I should mention that, I am currently a visiting scientist working with Google and, this nothing I say here should be interpreted as being the official position of Google. All right.
So with that I will get started. I wanted to talk today about the effects of heat on health, which is, very well described in the scientific literature and connect that to why we have sort of this disconnect between, what we know about heat and the fact that people continue to die of a heat related illness. So the problem, as I see it is that excess heat is a widely recognized threat to public health. It’s often cited based on CDC statistics that in the U.S more people die that in the U.S more people die of extreme heat each year than of any other meteorologic event. So despite all this knowledge, that we have about the risks of days of extreme and perhaps moderate heat, there seems to have been remarkably little progress towards preventing heat related illness and death. So we still see that heat waves are a major source of morbidity and mortality across the world. And so this got us thinking that this suggests a lack of translation of the abundance scientific knowledge about risks into public health action. And so just to highlight the point for those that may not be as familiar.
So a Seminole study by Antonio Gasperini and colleagues, published several years ago and have since published extensively, globally on the impacts of heat on health. And just to zoom in on a couple of locations, you could see that there’s this, a U shaped relationship between daily maximum temperature and the relative risk of 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. Interestingly although heatstroke has the biggest relative risk because it’s relatively uncommon as a diagnosis, the risk differences is smaller than for some other causes. So terrific work. This is just a sampling. There’s a huge literature now on this, and very large studies demonstrating that extreme heat is associated with higher rates of death and hospitalization all across the world. Moderate heat is associated with higher rates of death, and building amounts of evidence suggesting also with hospitalization.
And we know that the vulnerability of these effects varies by personal housing and neighborhood characteristics. Further we know that the U.S has already warmed more than a degree and is projected to warm further through the end of the century in substantially with that, regional substantial regional variation and how much, further warming we expect to see. So how do we translate this into action that actually saves lives and reduces the health impact? So local public health and emergency preparedness officials need to know something a little bit different. They need to know what are the health risks associated with a given climate hazard in my location, what local actions can I take 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 between 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 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 that you see there on the left and deaths there as you see there on the right. And, 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,
for mortality relative to some mortality were somewhat imprecise.
So, the, I think the key part of this is,
to translate sort of relative risks and smooth curves, which are available,
with standard software now,
thanks in large part to work by Gasperini and colleagues,
is to translate that into real numbers.
So a curve is all good but how does that translate to
number of excess ed visits or excess deaths attributable to days of different heat indices?
So we created this table where the bottom row here shows you on all the days of 100 degrees
with a heat index of 100 degrees or higher,
how many excess deaths,
excess CD visits were there on the same day,
or,
incorporating the lag effects up to seven days.
And so, across these 15 new England towns,
there were 39 additional ed visits
on all days over 100 degrees and 232.
If you incorporate the lag structure,
the fact that the next day
might also have some excess ed visits
and about four to eight excess deaths
for the days above 100 during this time period.
And, obviously there’s more days that are at, or above 95 degrees.
And so then, those numbers are bigger and, at, 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, and said, look, we think that at temperatures below that, or which you currently issue heat advisories. So 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.
I’m gonna skip ahead to the national weather service.
Okay, sorry.

So before I get to the national weather service story,

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 deaths attributable to heat across the country?

And so using data that we had a mortality through 2006,

she estimated that there were 5,000 or more excess deaths per year across the U.S attributable to heat.

This number is really important because it’s about an order of magnitude higher than what the CDC estimates report for heat related deaths that are those coded as being due to heat.

And so when we think of sort of the public health burden of disease of heat related illness,

the CDC estimates, are important,

but we think a likely an underestimate of the true excess mortality due to heat.

The other important point here is that if we separate out the extreme heat days versus the moderate heat days,

so we defined extreme heat as those days above the 95th percentile for a particular location.
And these 297 counties across the U.S. The burden of disease is actually bigger for deaths due to moderate heat. And that’s been reported previously, across the world and in the U.S but it, this puts concrete numbers on that that moderate heat accounts for a substantial burden of disease. And the other key point from this study is that, the risk, or the excess mortality is not distributed uniformly across the U.S and there’s 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. So 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, of actions that the public can take to protect their health.
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, and the optimal thresholds for issuing these heat advisories or heat warnings, remain largely unknown or unstudied, refer to heat advisories and warnings together as heat alerts. 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. And 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, a major public health victory, 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.
366 00:17:20.610 --> 00:17:24.270 through evaluation of data in New York city.
367 00:17:24.270 --> 00:17:28.082 And so the question we were asking is,
368 00:17:28.082 --> 00:17:32.410 what is the optimal threshold for issuing heat
alerts,
369 00:17:32.410 --> 00:17:34.811 heat warnings, and heat advisories.
370 00:17:34.811 --> 00:17:38.490 But these conversations assume that issuing
371 00:17:38.490 --> 00:17:40.480 heat advisories and warnings actually
372 00:17:40.480 --> 00:17:44.170 reduces heat-related morbidity and mortality.
373 00:17:44.170 --> 00:17:48.060 And there’s been relatively few studies on
that question.
374 00:17:48.060 --> 00:17:51.400 What, again, there’s a handful of studies,
375 00:17:51.400 --> 00:17:55.163 but one that I particularly like is this study
from,
376 00:17:56.050 --> 00:18:01.040 Tarik Benmarhina while he was still at McGill
and looking,
377 00:18:01.040 --> 00:18:02.800 taking a very creative approach to looking
378 00:18:02.800 --> 00:18:05.610 at the effectiveness of the heat action plan
that including
379 00:18:05.610 --> 00:18:09.563 included a new heat early warning system on,
381 00:18:14.350 --> 00:18:18.857 And, that team reported that the,
382 00:18:18.230 --> 00:18:24.850 that having this heat action plan implemented
in Montreal,
383 00:18:24.850 --> 00:18:26.770 reduced mortality during hot days
384 00:18:26.770 --> 00:18:28.833 by about two and a half deaths per day,
385 00:18:29.780 --> 00:18:33.680 and with particularly larger effects amongst
the elderly.
386 00:18:33.680 --> 00:18:36.915 So we wanted that’s exactly the question
387 00:18:36.915 --> 00:18:39.010 we wanted to ask is the issuing of heat warn-
ings,
388 00:18:39.010 --> 00:18:40.800 heat early warning system.
389 00:18:40.800 --> 00:18:44.343 How much does that benefit the population?
390 00:18:44.343 --> 00:18:48.790 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 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 heat warnings could be as effective as they were observed to be in Philadelphia during this time then a city like New York, Dallas or Phoenix, could potentially save avert 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,

cross 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,

each time that a heat warning

was activated at saved two and a half lives per day.

The heat warning system, she estimated,

each time that a heat warning

was activated at 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, 3% 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, 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,
518 00:25:28.689 --> 00:25:31.960 so our national weather service heat warnings effective,
519 00:25:31.960 --> 00:25:35.070 they may reduce the risk of death in some cities,
520 00:25:35.070 --> 00:25:37.010 but we don’t yet see evidence of
521 00:25:37.010 --> 00:25:40.145 widespread health benefits.
522 00:25:40.145 --> 00:25:43.291 And if that’s true and again it needs to be confirmed,
523 00:25:43.291 --> 00:25:47.220 but that would represent a missed opportunity
524 00:25:47.220 --> 00:25:50.093 to prevent heat-related morbidity and mortality.
525 00:25:51.050 --> 00:25:53.900 There’s lots of limitations to the analysis I’ve shown here,
526 00:25:53.900 --> 00:25:58.900 and we’re working to actively to address these limitations.
527 00:25:59.210 --> 00:26:00.833 So I just wanna emphasize the,
528 00:26:01.786 --> 00:26:05.130 that we’re at the beginning of the road here not the end.
529 00:26:05.130 --> 00:26:08.820 Okay, so I wanna turn to talking about,
530 00:26:08.820 --> 00:26:12.940 how susceptibility to heat related illness
531 00:26:12.940 --> 00:26:14.190 might vary by age groups.
532 00:26:15.200 --> 00:26:19.935 And, so in one of the first studies we did in Rhode Island,
533 00:26:19.935 --> 00:26:23.176 we looked at emergency department visits,
534 00:26:23.176 --> 00:26:27.390 to the to Rhode Island over several years now,
535 00:26:27.390 --> 00:26:29.420 there’s only a million people in Rhode Island.
536 00:26:29.420 --> 00:26:34.420 So again, there’s an issue about statistical power.
537 00:26:35.070 --> 00:26:37.406 But the interesting thing is that, of course,
538 00:26:37.406 --> 00:26:39.460 we all think of the elderly as really vulnerable.
539 00:26:39.460 --> 00:26:43.580 And what we saw is that for heat related ed visits,
540 00:26:43.580 --> 00:26:47.570 in fact, the relative risk was a lot higher,
541 00:26:47.570 --> 00:26:49.952 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, 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 as well as the relative size and contribution. And so a little bit hard to see here, but so 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.
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 much less explored associations between different causes of ed visits in children and adolescents and temperature. So, more to be done there, but 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, those 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 are 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 information in the Southeast tends to have more information in the Southeast.

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, 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, children that spend a lot of time outside, perhaps children’s spending time in non-air conditioned schools,
645 00:32:07.355 --> 00:32:10.363 can also be quite a bit at risk.
646 00:32:12.430 --> 00:32:13.263 Okay.
647 00:32:13.263 --> 00:32:15.830 So turning back to the, the bigger, framework.
648 00:32:15.830 --> 00:32:18.090 So on a global and national scale,
649 00:32:18.090 --> 00:32:20.115 we think that we understand
650 00:32:20.115 --> 00:32:22.160 the adverse health impacts of heat.
651 00:32:22.160 --> 00:32:24.160 But there’s been this lack of translation
652 00:32:24.160 --> 00:32:26.627 of abundance scientific knowledge on the risks
653 00:32:26.627 --> 00:32:30.300 and to public health action in terms of prevention.
654 00:32:30.300 --> 00:32:32.130 And so, again,
655 00:32:32.130 --> 00:32:34.690 this means that there’s insufficient evidence
656 00:32:34.690 --> 00:32:36.200 to guide the public health response
657 00:32:36.200 --> 00:32:38.423 to present day or future heat.
658 00:32:39.320 --> 00:32:44.320 If we were designing, optimal response to heat,
659 00:32:44.370 --> 00:32:47.590 Jeremy Hess and Kristie Ebi have written
660 00:32:47.590 --> 00:32:50.420 nicely about this,
661 00:32:50.420 --> 00:32:52.000 you’d define dangerously hot weather,
662 00:32:52.000 --> 00:32:54.670 you’d forecast it well,
663 00:32:54.670 --> 00:32:57.850 you’d identify who’s at greatest risk of these
664 00:32:57.850 --> 00:33:00.650 You’d intervene to reduce those health impacts,
665 00:33:00.650 --> 00:33:02.590 you’d evaluate the effectiveness of those interventions.
666 00:33:02.590 --> 00:33:05.500 And you do this on a continuous cycle.
667 00:33:05.500 --> 00:33:08.423 You’d do this repeatedly to continue to optimize.
668 00:33:08.423 --> 00:33:10.710 So, our broader research agenda
669 00:33:10.710 --> 00:33:14.210 follows mirrors these image.
670 00:33:14.210 --> 00:33:16.591 So, the vision that we have is that
671 00:33:16.591 --> 00:33:19.190 we could provide the evidence needed for any community
in the U.S to mitigate the adverse health impacts of extreme heat.
And I’d probably amend that now to say both extreme and moderate heat,
although we recognize that they require different strategies,
the same strategies won’t be effective for both,
thinking about moderate and extreme heat.
The concrete sort of next steps in that is to identify optimal health based and location specific metrics for issuing heat alerts.
We wanna follow up our work on the benefits of heat alert’s heat warnings and heat advisories, 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 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, across 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, 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
and 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, 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
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 predict-
ing,
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
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 inter-
esting one.
There’s,
I think that it’s potentially very interesting,
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.

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. So, by so we had to limit ourselves to those days in which, we sometimes saw a heat warning but not always. And if, a 90 degree day,
nobody’s issuing heat alerts and on 110 degree day,
everybody’s issuing heat alerts. And so we had to focus on the middle. So one of the limitations of this work is that it is there’s no counterfactual, there’s no information about the counterfactual of like, what would have happened had we not issued a heat alert on a very, very hot day? There’s just, there’s no data is conditional on location. So that is one of the challenges. So we should, our results are generalizable to those days on which you might, or sometimes issue heat alerts. And not outside of that relatively narrow band of temperatures. I think we do have a question from the audience, one of the first, so, the question from Stephan Lessen is asking 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,

you 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,

you, 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, or helping them protect themselves, rather than sort of just an information deficit model.

So I think that there’s 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, or helping them protect themselves, rather than sort of just an information 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

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 that 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 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. Thanks.

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 how do you actually verify the causal assumption in evaluating the heater systems? Yeah, that’s great. So, the best we can do is use the data, this isn’t a randomized, these aren’t randomized studies. So the best we can do is, use observational data to the best of our ability. So, can we ever prove that we understand the causal effect of heat alerts? No, but I think we can do, more detailed, more insightful analysis of the existing observational data. And I think this idea of there are a range of days. So going back to the heat warnings, there’s these days where we say, we’re always going to issue a heat warning, ’cause it’s just so hot that we just take it for granted that it’s dangerous and we need to do something, so we’re going to do it. And then there’s this other bucket, a days on the other end where like, it’s just, issuing key warnings is just not likely to be effective,
but there’s this middle range where you’re like, should I issue a heat warning?
Yes or no. And so what we’re doing is providing information on that part, the spectrum, and where we say, should we issue somewhat more heat alerts because we can do it right around this threshold, would that save lives?
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’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

from Donna Spellman.

I’ve been struggling to see how implementation science

might promote environmental health.

This project is a perfect example of the connection.

Thanks.

Thanks Donna.

I think that’s a great point.

And I think that there I have not seen a large amount

on implementation science,

specifically oriented towards solutions

in environmental health.

We’re really great at describing problems

and less good at figuring out and implementing solutions

and then evaluating their effectiveness.

So I think that this is right for that
because we know there's a risk there.

We just don't actually know exactly what to do about it.

And there are lots of good ideas,

but we need to move from good ideas to,

good evidence supporting specific ideas.

- Great.

I think with that we will conclude, this seminar

and thank you Greg, for this wonderful presentation

on the science-based actions.

And, this seminar will be recorded

and will be posted later.

So thank you all for coming and thanks again Greg.

- Wonderful thanks for the opportunity, bye bye.

- Bye.