Multihazard Weather Risk Perception and Preparedness in Eight Countries

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ABSTRACT

Weather risk perception research lacks multihazard and transcultural datasets. This hypothesis-generating study used a cognitive behavioral approach and Brunswik's lens model for subjective risk parameters across eight countries. In Germany, Poland, Israel, the United States, Brazil, India, Malaysia, and Australia, 812 field interviews took place with a uniform set of 37 questions about weather interest, media access, elementary meteorological knowledge, weather fear, preparedness, loss due to weather, and sociodemography. The local randomized quota samples were strictly tested for sample errors; however, they cannot be considered representative for individual countries due to sample size and methodology. Highly rated subjective risks included flood, heat, tornado, and lightning. Weather fear was most prominent in the Malaysian sample and lowest in the German.

Subjective elements were further explored with bivariate correlations and a multivariate regression analysis. Sociodemography correlated with psychological variables like knowledge, interest, and fear. Fear was related with subjective risk; less educated and informed people were more fearful. A linear regression analysis identified interest, gender, housing type, education, loss due to weather, and local weather access as the significant predictors for preparedness. The level of preparedness was highest in the United States and Australia and lowest in the Malaysian and Brazilian samples. A lack of meteorological training and infrequent loss experiences make media communication important and emphasize the value of repetition for basic information. Elements of this survey can serve to monitor weather-related psychological orientations of vulnerable population groups. Finally, this survey provides a template with which larger representative transcultural multihazard perception studies can be pursued.

1. Introduction

Cultural differences can result in large variations in the perception of and response to the risk posed by severe weather phenomena, and little consideration has been made of how multiple hazards are perceived. The World Meteorological Organization (WMO) defines severe weather as a

> dangerous meteorological or hydrometeorological phenomenon, of varying duration, with risk of causing major damage, serious social disruption and loss of human life, requiring measures for minimizing loss, mitigation and avoidance, and requiring detailed information about the phenomenon (location, area or region affected, time, duration, intensity, and evolution) to be distributed as soon as possible to the public and responsible authorities (WMO 2004).

Meteorological services and mass media provide the general population with a variety of forecasts and warnings. As informed citizens, laypeople have to transfer general hazard information into individual preparedness actions. Because extreme weather impacts lead to severe emotional distress and trauma, disaster preparedness, response, and resilience are important social and political issues (Peek and Mileti 2002). Recently, the U.S. National Academies of Sciences, Engineering, and Medicine formulated one of the key findings in their implementation study: ''Meteorologists and others in the weather

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enterprise could benefit from a more realistic understanding of the diverse disciplines, theories, and research methodologies used within the social and behavioral sciences'' (Committee on Advancing Social and Behavioral Science Research and Application with the Weather Enterprise et al. 2018).

The main approach in risk perception research is psychometric, cognitive behavioral or rational choice theory. Shreve et al. (2016) divide this approach into cognitive behavioral theories and social-cognitive theories. Cognitive behavioral theories take a factor-analytic approach to identify individual hazard patterns in risk perception. Social-cognitive theories, like protection motivation theory (PMT; Rogers 1975) or theory of planned behavior (TPB; Ajzen 1985), take into account influences of communities or social reference groups on individual behavior. In the realm of cognitive-behavioral theories, prospect theory has noted a greater fear of losses than hope for potential gains (Kahneman and Tversky 1979). Subjective risk assessment of technology risks (Slovic 2000) is guided by availability; that is, easily imagined and remembered risks evoke more aversive behavior, while the event dread factor is defined by the ''perceived lack of control, catastrophic potential, fatal consequences'' (Slovic 1987).

Reviewing the broader applications of these approaches, Shreve et al. (2016) note a deficit in the proper choice of methods for different hazard types and contexts as well as ''the limited number of studies in the literature that examine preparedness behaviors for multiple hazard types simultaneously.'' One example of this type of analysis is the assessment of 20 meteorological risks over the United States (Thompson Fox-Glassman 2015). Further to this limitation, meta-analyses of preparedness studies for natural hazards are missing. Often, such analyses are complicated, as studies do not utilize a theory in their sampling approach, which makes comparisons between studies a difficult task.

An alternative approach to risk perception theory is the cultural theory of risk (Douglas and Wildavsky 1982), which concentrates on ways of life—hierarchy, egalitarianism, individualism, and fatalism—that shape risk perception. Cultural biases are not individual, but related to society. However, cultural theory has been criticized for its typology and explanatory power. Marris et al. (1998) could only allocate 32% of British respondents unequivocally to one of the four types. Sjöberg (1998) and others found the cultural theory scales to perform poorly in representing the overall population. Similarly, Brenot et al. (1998) reported that these scales only explained 6% of risk variance in France. As cultural weather bias was never explicitly defined, too, this system was not used in our exploratory study.

The majority of detailed interdisciplinary studies linking the social sciences, geography, and meteorology have focused on singular hazards: for example, floods in Europe (e.g., Baan and Klijn 2004; Grothmann and Reusswig 2006; Harries 2008; Terpstra 2011; Bosschaart et al. 2013; Maidl and Buchecker 2015; Kanakis and McShane 2016; Brennan et al. 2016; Kuo 2016) and tornadoes in the United States (e.g., Balluz et al. 2000; Sherman-Morris 2010; Godfrey et al. 2011; Stokes 2013; Paul and Stimers 2012; Blanford et al. 2014; McCormick et al. 2014; Klockow et al. 2014; O'Brien and Schultz 2015; Ripberger et al. 2015; Jauernic and Van Den Broeke 2016). Terpstra (2011) tested a theoretical flood risk path model that included subjective flood risk, previous experiences, and feelings of trust and solidarity. Meta-analysis has also been conducted for flood risk (Wachinger et al. 2013; Kellens et al. 2013). Wachinger et al. (2013) qualitatively reviewed 35 European studies, identifying a ''risk perception paradox,'' where high flood risk perception did not improve personal preparedness directly, only via contextual and social factors. In contrast, using a larger sample (57 flood studies), Kellens et al. (2013) identified that most existing studies are exploratory and lack theoretical frameworks, while studies on flood risk communication were nonexistent. Interdisciplinary U.S. tornado studies, in contrast, focused on understanding and communication, testing lay knowledge, and the efficiency of the warning process. McCormick et al. (2014) explored using a pre- and posttornado outbreak preparedness survey, which found that within 6–9 months of an event, 86% of the respondents reported more thoughts about preparedness, and 60% reported they had taken actions to increase it. Similar analysis by Silver and Andrey (2014) investigated previous disaster experience as a motivator for protective behavior in two subsequent tornado events in Canada. Within this context, no simple amplification effect was found; rather, a complex interaction of experience and sociodemographics was revealed. The limitations of these prior studies suggest that further research considering multihazard analysis is necessary, similar to the approach by Thompson Fox-Glassman (2015).

Transcultural studies also play an important role in understanding differences in the perception of meteorological risk. The Intergovernmental Panel on Climate Change (IPCC) supported numerous field studies on indigenous/traditional weather knowledge and practices worldwide, especially in Africa, Asia, and the Americas (e.g., Alexander et al. 2011; Hikuroa 2012; Berghan 2014). The most detailed cross-cultural risk perception review by Renn and Rohrmann (2000) lists 14 national studies covering 10 to 100 social and technological hazards from 16 countries. Only one study included a meteorological risk: lightning (Bulgaria vs Romania; Sjöberg et al. 2000). Solberg et al. (2010) presented a review of seven countries on the social psychology of seismic hazard adjustment, but no systematic general population studies have, to date, tried to assess whether there are similarities or differences in weather risk perception and responses across cultures.

Laypeople encounter media weather reports in an everyday context, often listen casually, and distill their individual interests from the broadcast message. Murphy (1993), for example, stated that forecasts possess no intrinsic value but only acquire it when they are able to influence the decisions made by their users, though the basis for this commentary was not formally surveyed or analyzed. The layperson perspective has only relatively recently moved into focus in forecasting, driven by the lack of response to warnings for severe weather (Balluz et al. 2000; Doswell 2003). In this vein, Demuth et al. (2011) criticized little information about the use of weather forecasts by the U.S. public. In their internet-based complex survey of 1461 respondents, they found that weather reports were chiefly used for everyday and leisure purposes (e.g., dressing, especially by females), with temperature, wind, and precipitation as central foci. Older and precipitation-oriented users obtained forecasts more frequently, while the percentage of time spent outdoors was also a major influence. Kox and Thieken (2017) surveyed 1342 Berlin residents about their decision thresholds for protective behavior in case of severe weather warnings. A tested garden frost scenario showed no consistent action threshold with rising hazard, also when taking into account education and housing type, but prior direct experience, self-efficacy, and trustworthiness of the weather information had effects. While warning ineffectiveness has motivated study for many areas of severe weather, social science research on synoptic phenomena has been relatively infrequent (e.g., Wagenaar and Visser 1979; Wagenaar et al. 1985; Stewart et al. 1992; Gigerenzer et al. 2005; Keul and Holzer 2013). Part of the challenge for such studies is that translating synoptic forecasts into colloquial language and adapting them for special interest populations is a complex task and cannot be solved with a simple information-processing paradigm.

The WMO has supported national surveys on weather service quality from 2001 to 2010 (PWS WMO 2016) in Ireland, the Indian Ocean and Seychelles, Germany, Great Britain, Australia, South Africa, Belarus, Hong Kong, and the United States (Jacks et al. 2015). A cooperation of social sciences with the Austrian radio and television company ORF led to a series of field studies in 2008–11 on the lay relevance and legibility of radio and television weather reports in fair weather and warning situations (Keul and Holzer 2013). The lay surveys used nonstandardized, ad hoc operational questionnaires without a theory base, so a meta-analysis is not possible. Only a few comparisons were done using the reports from Germany (Forsa 2006; $N = 1004$), South Africa (Falconer 2009; $N = 315$), Great Britain (GfK NOP Social Research 2009; $N = 2204$; 2223; 2207), the United States (Powell and O'Hair 2008; $N = 769$), Australia (Maddern and Jenner 2010; $N = 1761$), Belarus (Republic of Belarus 2010; $N = 423$), and Canada (EKOS Research Associates 2011; $N = 2333$), and matching it with the data from Austria (Keul and Holzer 2013; $N = 484$): Fast media (i.e., TV, internet, radio) were identified as the main weather information sources in Germany, Austria, Great Britain, Belarus, and Canada. However, the impacts of smartphones and mobile phone weather services were untestable, as they developed rapidly during the survey period. In Canada, Germany, and Austria, weather warnings received more interest than routine messages. Interest and satisfaction with the weather information were found to be high in Great Britain, South Africa, Australia, and Canada. In the United States, older people were more satisfied than younger users. In Belarus, only 14% found the forecasts accurate. Like in the United States (Demuth et al. 2011), survey responders from Canada and Belarus pointed out temperature and precipitation as the most relevant elements and the next day as the most important time interval. In Austria in 2010, up to 86% of responders demanded that weather elements should always appear in the same order. These factors suggest that users are particularly exacting when it comes to consumption of weather information, and thus, comparing these aspects may also provide informative cross-cultural insights.

This review reveals a considerable gap in our understanding of both transcultural and multihazard risk perception, particularly with respect to severe weather, and the intersection of these two important analyses. To address this limitation, the concept to explore lay weather perception for multiple countries was first discussed with colleagues at the European Conference on Severe Storms 2011 and continued in 2013. This led to an informal expert network to study and compare lay knowledge, hazard assessment, and risk preparedness in different countries. The aim of the explorative International Severe Weather Survey (ISWS), using a uniform survey procedure, was threefold: 1) to test the utility of a multihazard survey instrument in colloquial language in different cultural samples to assess the lay perception of hazardous weather phenomena and whether a single survey instrument was capable of

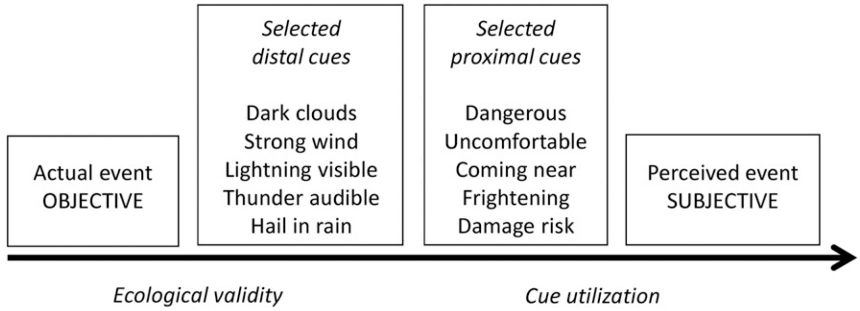

FIG. 1. Lens model of Brunswik (1956), schematized by Gifford (1997, p. 25) as a thunderstorm example.

assessing differences that arose culturally; 2) to explore whether specific demographic factors (e.g., gender, education, or age differences) played a role in risk perception and whether this varied transculturally, thereby motivating further larger, truly representative sample studies; and 3) to explore statistical interrelations among the main variables to better inform the origins of an individual's risk perception and whether this is variable between cultures (e.g., personal loss due to weather vs subjective risk assessment.) In doing so, this study describes a template from which future analyses can consider transcultural multihazard risk perception.

2. Methodology

a. Theoretical basis

The multiple hazard study herein falls into Shreve et al.'s (2016) psychometric paradigm trying "to understand why people perceive risks differently by identifying factors that underlie these perceptions." The range of natural hazards studied was confined to meteorological and hydrometeorological phenomena stated in the WMO (2004) definition. Ten hazards were surveyed, belonging to different time scales and geographic contexts to address the lack of such intercomparisons. A transcultural approach was used, since this survey was conducted in eight countries on four different continents, using questionnaires in five different languages.

The cognitive-behavioral foundation of the study belongs to the tradition of probabilistic functionalism by Brunswik (1956), which was explicated by Gifford (1997, p. 24) for environmental perception: "Brunswik maintained that the environment offers a multitude of cues; the perceiver must make sense of the most important ones to function effectively in a setting." The perceiver gives probabilistic weights to each of the cues, which is called cue utilization, and can be pictured as a lens model (see Fig. 1) about the projection of a distal (distant) objective event into the proximal (near) subjective representation of the observer. For Gifford (1997, p. 26), Brunswik "viewed perceivers as active agents, intentionally seeking views of the environment that assist them as they make their way through the world." This is also a constructivist position.

Figure 2 shows the position of these items in Brunswik's lens model: actual physical damage/loss of the hit score is an objective item, followed by objective sociodemographic aspects of participants (gender, age, education, children, and housing). On the subjective side of the lens model, psychological variables like weather knowledge, weather interest, and weather fear lead to the subjective selection of proximal cues and to values of subjective risk and personal preparedness.

b. Survey design

Without an elaborated theory on location- and culture-specific weather risk perception and behavior and without prior comparable empirical datasets, this led to a hypothesis-generating survey (Siemiatycki et al. 1986), rather than a systemic analysis as an explanatory experiment with untested causalities (Babbie 2006; Singh 2007). The lack of appreciable analysis for cross-cultural and multihazard perception drove a preliminary assumption that subjective risk perception and preparedness would differ among cultures, gender, age, education, housing type, and the number of children in the household. Sample-taking followed the statistical theory (Starnes et al. 2010) of a simple random sample, with individuals chosen by chance from a population throughout the sampling process. A gender proportion of 50:50 and a mix of age groups was realized. The suburban samples—for example, pedestrians at public spaces, such as supermarkets—were representative for the survey areas, but not for the population of the respective country.

To cover geographical and climatological variety in the different cultural regions, surveys were planned for all continents. However, based on investigator availability, survey datasets of about $N = 100$ were realized in Europe (Germany, Poland), the Near East (Israel), the Americas (United States, Brazil), Asia (India, Malaysia), and Australia (Fig. 3). The survey regions,

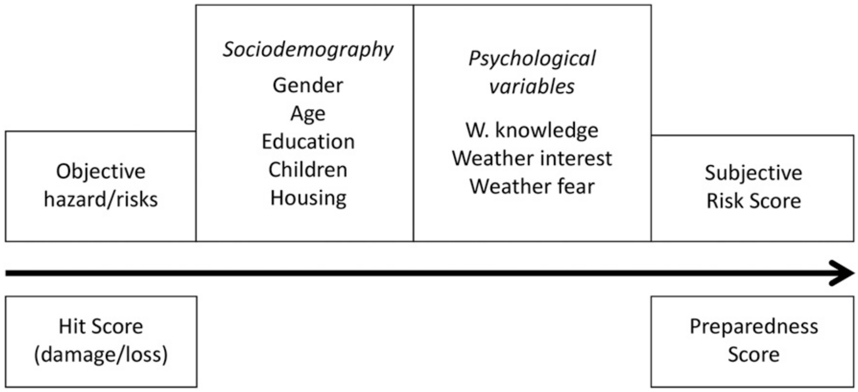

FIG. 2. Lens model arrangement of main meteorological risk perception variables.

their heights above mean sea level, their Köppen climate types, the rounded yearly numbers of thunderstorm days, and the yearly estimates of tornado parameter days are described in Table 1. Based on the National Aeronautics and Space Administration's (NASA) global lightning maps (Christian et al. 2003; Jentoft-Nilsen 2006), three of the eight survey locations (Oklahoma City, United States; Campinas, Brazil; and Kuala Lumpur, Malaysia) were located in convective areas with lightning flash frequencies over 10 km^{-2} yr^{-1}.

Academic partners from meteorology and geography collected local quota samples. All empirical data were self-reported. A two-page instrument on severe weather and lightning was used. Thirty-seven items covered media weather (report) interest/sources/legibility, elementary meteorological knowledge, subjective risk assessment (with lightning as a special topic, not presented in this report), personal preparedness, self-reported behavior, experienced physical damage (loss) by weather events, and sociodemographic data. To facilitate the statistical analysis, two weather interest items (Q1 and Q3 in questionnaire) were combined as an interest score, 10 risk assessment items (Q9) as a risk score, four weather knowledge items (Q11–Q14) as a knowledge score, three preparedness items (Q16–Q17) as a preparedness score, and three physical damage items (Q21–Q23) as a hit score. For the eight countries, translated language for the survey was based on the native tongue: English (United States, Australia, India), Portuguese (Brazil), Polish (Poland), Hebrew (Israel), Bahasa Malaysian (Malaysia), and German (Germany). Translations were completed by bilingual native meteorologists/geographers and were pretested for legibility and unambiguity. The English version of the survey can be found in the appendix.

c. *Survey geography and climatology*

In India, Nagaland state is situated in the northeast; 94% is hilly and rugged up to 3841 m, with dense vegetation (NSDMA 2012). Nagaland state has a humid subtropical climate with mild summers. A 1985–2004 study found an average annual rainfall of 1551 mm, mostly during the monsoon months of June to August

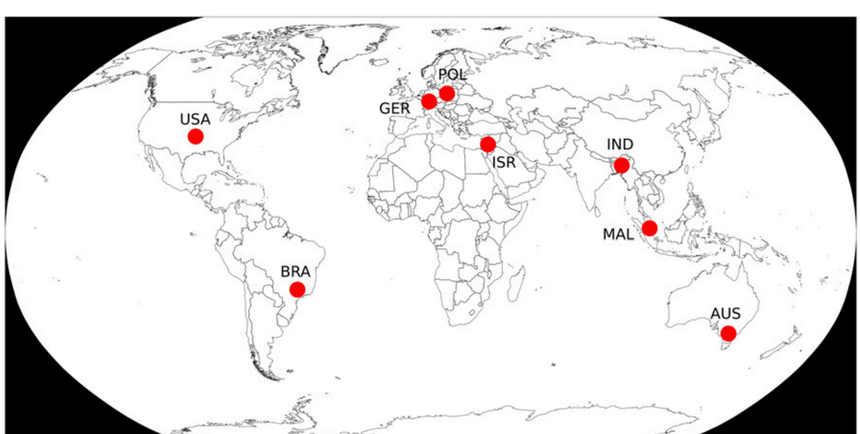

FIG. 3. World map with the eight ISWS survey sample areas.

TABLE 1. Survey sample regions, heights, Köppen climate type (Peel et al. 2007), thunderstorm days yr^{-1} (India Meteorological Department 2013; Kolendowicz et al. 2017; Goldreich 2012), and tornado days yr^{-1} (favorable conditions; Brooks et al. 2003b).

Region	m MSL	Köppen climate type	~Thunderstorm days yr^{-1}	~Tornado days yr^{-1}
Munich, Germany	519	Dfb/Cfb humid continental/temp.oceanic	30	2–4
Poznan, Poland	60	Cfb temperate oceanic	20	<1
Tel Aviv, Israel	5	Csa Mediterranean	20	0
Oklahoma City, United States	396	Cfa humid subtropical	50	10–12
Campinas, Brazil	685	Cwa/Aw humid subtropical/trop.savanna	80	4–6
Kohima, India	1382	Cwa humid subtropical	10	2–4
Kuala Lumpur, Malaysia	22	Af equatorial	200	0
Melbourne, Australia	14	Cfb temperate oceanic	15	0–2

(Rajeevan et al. 2006). Nagaland is geologically unstable with continuous tectonic activity. Together with monsoon rain, this makes damaging landslides a common occurrence.

The Brazilian survey region is located in the subtropical climate area with a precipitation average of 1400 mm, 70% in spring and summertime. Heavy rainfall and winds are common; the area also experiences tornadoes. Urban expansion and deforestation have recently resulted in increased floods (Nunes and Fernandes 2013).

The German survey area is in the foothills north of the Alps, on the border of oceanic/humid and warm summer continental climate. The temperature maximum falls into July, and shower and thunderstorm precipitation is high from late spring throughout summer. Local hazards include severe convective storms producing hail and damaging winds, along with tornadoes (Dotzek 2001).

Israel is located near the eastern Mediterranean Sea and experiences no rainfall in the summer months (Goldreich 2012). The maximum rainfall period is during winter, while the most severe weather occurs during the transition months of spring and fall. Flash floods are fairly common in the desert regions, while hail storms, lightning, and strong winds can also be present. Tornadoes have been observed infrequently.

The climate of Malaysia is driven by its equatorial position, extensive coastlines on tropical seas, and monsoonal winds. The resulting climate has uniformly high temperatures, high humidity, relatively light winds, abundant rainfall, and high lightning density. The southwest monsoon winds blow from April to September, and the northeast monsoon is from November to February (Lim and Samah 2004).

The Polish survey area is in the temperate zone of central Europe. The lack of meridional mountain ranges promotes latitudinal airflow. The transition between the marine climate of western Europe and the continental eastern climate results in a large annual variability of observed weather conditions and extreme events. These include thunderstorms (Kolendowicz et al. 2017), lightning, tornadoes (Taszarek et al. 2016), large hail, heat waves, and floods (Kundzewicz et al. 1999).

In the U.S. survey area, residents of Oklahoma are familiar with springtime thunderstorms that bring with them flooding and severe weather, including lightning, hail, wind, and tornadoes. Many reported U.S. tornadoes occur in this region (Brooks et al. 2003a).

The Australian survey took place in Melbourne, located in the southeast of the mainland continent. Its climate is temperate oceanic; however, its proximity to ocean and deserts can lead to large shifts between extreme heat and cold frontal systems. This juxtaposition leads to regular heat waves, bushfires, and severe convective storms producing heavy rainfall, damaging winds, hail, and tornadoes (Allen and Allen 2016).

3. Results and discussion

a. Survey sample descriptions

The international survey was completed between 2012 and 2015. The eight survey samples, ranging from 80 to 129 persons, were representative of the limited (sub) urban population groups present as pedestrians in public spaces, such as supermarkets. National and local (urban) demographic parameters were different among the samples. For example, India has a national population density of 421 km^{-2}, but 81% of the Indian ISWS sample comes from Kohima, Nagaland, with a population density of approximately 13 000 km^{-2}. In Brazil, the national density is 24 km^{-2}, but the ISWS survey area, Campinas, has a population density of about 1400 km^{-2}. The spatial characteristics of the street survey samples are briefly described and geocoded (Figs. 4a–h).

Eighty-one people from the Indian sample ($N = 100$; 2012; Fig. 4a) come from Kohima, the capital of Nagaland (2011 population 267 988; density 13 400 km^{-2}; National Informatics Centre, Kohima District Centre 2016), 10 are from the larger town of Dimapur, and nine come from other places.

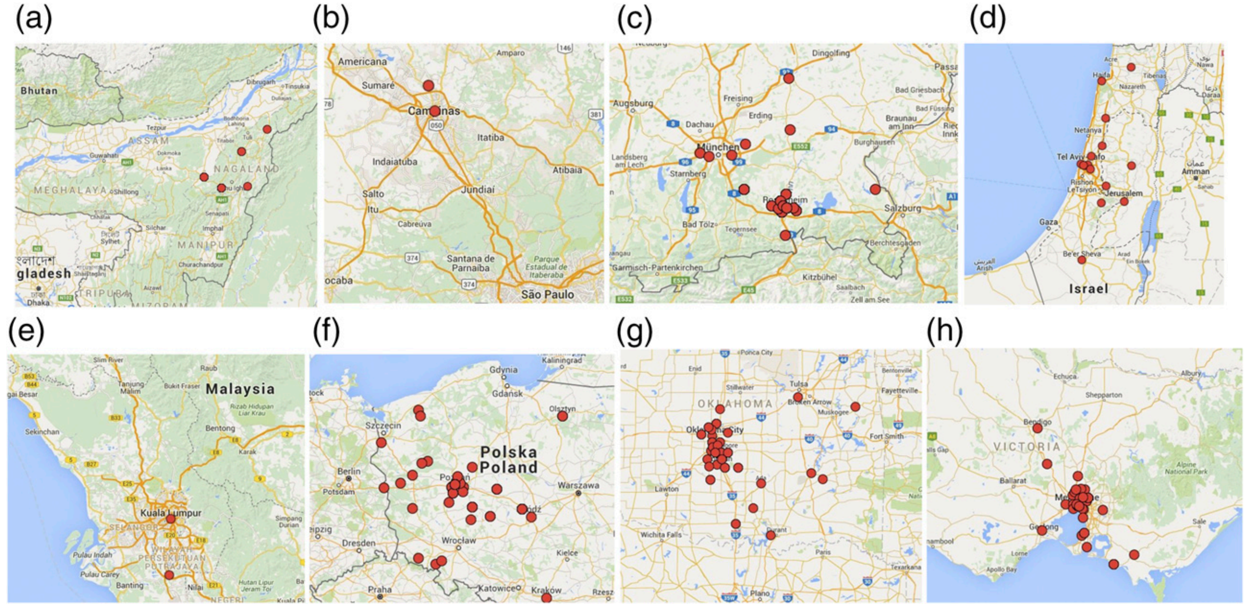

FIG. 4. ISWS sample residence maps. (a) India/Nagaland (1:17Mio), (b) Brazil/São Paulo/Campinas (1:3Mio), (c) Germany/Bavaria (1:5Mio), (d) Israel (1:7Mio), (e) Malaysia/Kuala Lumpur (1:4Mio), (f) Poland/Wielkopolskie (1:17Mio), (g) United States/Oklahoma (1:13Mio), and (h) Australia/Victoria/Melbourne (1:12Mio) (Google Maps 2015).

The Brazilian survey data (N = 104; 2012) are from Campinas in the federal state of São Paulo. In 2011, Campinas had 1 091 946 inhabitants (population density 1372 km^{-2}; Prefeitura de Campinas 2016). Interviews took place near the city center and in the district of Barão Geraldo (Fig. 4b).

The German survey (N = 80; 2012; Korff 2013) studied the Rosenheim district of southern Bavaria. Fifty-five people came from the town of Rosenheim (population 62 672; Bayerisches Landesamt fuer Statistik 2016), most of the rest came from communities nearby, and a few were from nearby Munich (Fig. 4c).

The Israeli survey started in 2015 locally in the Tel Aviv area (2013 city population 418 600; density up to 15 km^{-2}; Tel Aviv Yafo 2016), followed by a countrywide online survey. Of the 95 returned questionnaires, 49 were from central Israel (Fig. 4d).

The Malaysian survey (N = 129; 2013) was distributed to 60 people at the district Taman Desa Seputeh in the capital of Kuala Lumpur (city population 1 790 000; density 7366 km^{-2}; Department of Statistics Malaysia 2018) and to 69 people in the town of Dengkil in the southern Sepang district (Fig. 4e).

The sample from Poland (N = 99; 2013) was gathered mainly in Greater Poland Voivodeship (Greater Poland, population 3 467 016; Fig. 4f; Wielkopolska WARP 2016). Its central city, Poznan (2010 population 551 627; Aglomeracja Poznanska 2011), contributed 56 samples to the survey.

All 100 U.S. questionnaires were collected in downtown Norman, Oklahoma (2010 population 110 925; United States Census Bureau 2016), within one month of damaging and fatal tornadic outbreaks and flash flooding events in May 2013. Sample respondents also came from Oklahoma City, Tulsa, Moore, and Edmond (Fig. 4g).

The Australian street survey (N = 105; 2013) was conducted in the city of Melbourne at local supermarkets and public spaces around the city, (60%; 4 529 500 inhabitants in 2015; density 453 km^{-2}; Australian Bureau of Statistics 2016), with participants also coming from nearby Eltham (4%), Wonthaggi (3%), and other places where commuting to the city is common (Fig. 4h).

b. *Descriptive statistics*

1) POPULATION AND SAMPLE VALUES

As the ISWS samples were obtained over limited regions, they were assessed against population characteristics of the eight countries at Prevention Web (2015) to identify weaknesses. Populations ranged from over 1 billion inhabitants for India to 8.1 million in Israel. Urbanization was the highest in Australia and Israel, in contrast to India, where 68% of the population was rural. For all samples, we scheduled a gender sample ratio of 1:1. With the exception of Australia (39:61), the ratios were well balanced. The median age of the general population was lowest in India and Malaysia and oldest in Germany. Figure 5 shows that the median age of the ISWS samples was always between 25 and 35, except for Brazil. Population tertiary education was highest in

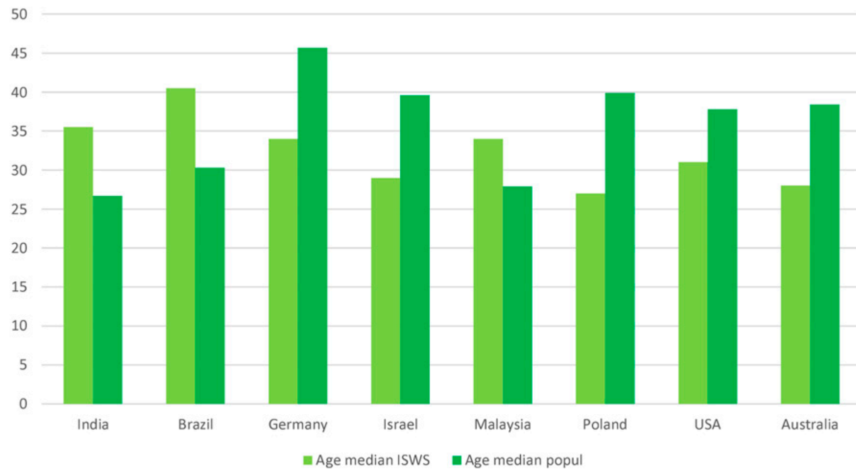

FIG. 5. Median age—ISWS survey samples vs general population. Population age median from CIA World Factbook 2013 (www.cia.gov).

Israel, the United States, and Australia, and lowest in India and Brazil. In Fig. 6, the German, Polish, and Malaysian ISWS samples had population tertiary education levels, but in all five of the other countries, ISWS tertiary education was higher, especially in India and Brazil. The geographical overview (Fig. 4) shows that all eight samples were urban, and four of them came from metropolitan areas of over 1 million inhabitants. This reflects a limitation in our sampling, as results for rural or other urban areas within each country may differ substantially. As five of the samples inexplicably reflect high academic education for sample participants, the results here also cannot speak for less educated and underprivileged segments [for reference, compare McCormick et al. (2014)].

2) Risk estimates

Table 2 lists the mean subjective risk estimates of the ISWS samples for 10 meteorological hazards. The ranks of the three highest risks are set in brackets. Overall, heat was seen as the highest risk in three samples (Israel, Malaysia, and Australia) and tornadoes in two (Germany and United States). Because of six survey locations with different proximity to mountain ranges, avalanches and snow were not considered primary risks, except in Bavaria and Nagaland. There were singular main risks (severe storm in Poland, landslide in India), and floods were rated as the main and second-rank risks in five samples. For the ISWS dataset ($N = 812$), the highest ranks for subjective risk means were flood (6.7), heat (6.1), tornado (6.0), and lightning (6.0).

3) Media access, local weather, and weather report quality

Comparing reported fast media access in the ISWS samples to TV and internet access rates for the population (Fig. 7), fast media access follows the density of electronic infrastructure, especially television, in six countries. The exceptions to this relation are in India, where people seem to share equipment with neighbors, and Brazil, where the internet may be more important. Asked about media report legibility, 8%–75% of laypersons found the ‘‘speed of the media weather reports,’’ as manifested by the speaking tempo of the report (explained during the interview), was deemed to be uniformly acceptable. This item of the questionnaire was answered in the affirmative by over 70% in the United States, Australia, and Israel, and by fewer than 10% in Germany. The most important time interval for media weather forecasts (Likert scale 0–10) was ‘‘tomorrow,’’ with a mean of 2.6 for all samples. In the United States and Poland, ‘‘2–3 days’’ were rated higher, and in India, ‘‘4–7 days.’’

Between 36% and 85% of the respondents said that they easily accessed information about their local weather (maximum: United States 85%; minimum: Germany 36%; Malaysia no data). As this item can be of high importance for severe weather warnings, it was also used for inferential statistics. The within-sample variance was very high as to whether media weather reports should suggest safety measures—from 9% in Germany to 75% in India. Asked whether safety measures should only be given in case of danger, consent ranged from 22% (India) to 90% (Australia), although a majority agreed in seven of the eight ISWS samples. Summing up the media access and report quality questions, it was learned that fast media weather reports reach over 50% of the samples, and in the majority of samples, over 90%. But differences between samples were high with respect to legibility and access to local weather. Also, the desire to get safety suggestions in case of danger was very different for the individual country samples.

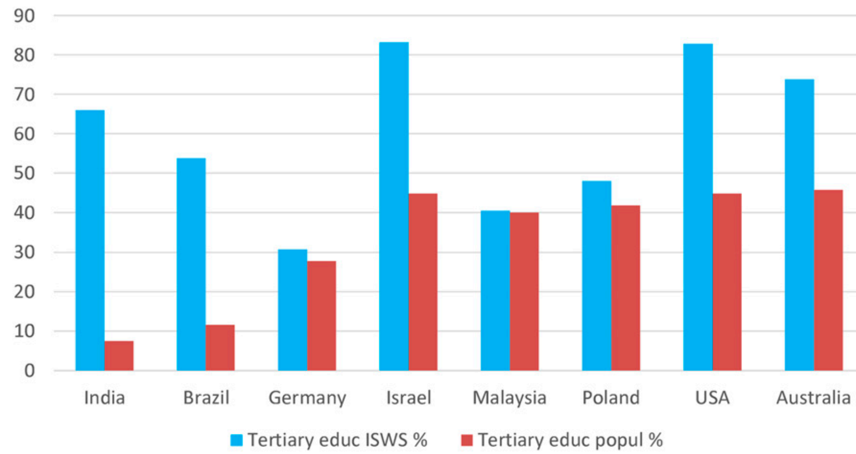

FIG. 6. Percentages of tertiary education—ISWS survey samples vs general population. Tertiary education of population from OECD 2013 Education at a glance (www.oecd.org).

4) Damage/loss experiences

Laypersons were asked for moderate or severe loss experiences (Fig. 8). Nearby lightning strikes were seen by over 50% in three samples (maximum: United States 82%), and below 15% in Israel and Malaysia. Lightning damage to homes was below 15% in five samples (minimum: India, Australia), and 32% in Brazil. Five samples reported limited flood home damage (under 10%; minimum: Israel 3%), of which Germany was highest, with 29%. For damage to homes by storms, two samples were under 15% (minimum: India 11%), five were below 50%, and the United States reached 74% (due to the higher climatological tornado risk in Oklahoma). Samples from India and Israel reported rather low overall damage/loss rates, and Germany and Malaysia reported higher rates for all three hazards, while samples from Brazil, Poland, the United States, and Australia had higher rates of damage for lightning and storms. The loss histograms of Fig. 8 give the sums of moderate and severe. As ISWS-reported losses were mostly moderate (Fig. 8), severe cases were combined with these totals, and the limited frequency suggesting inference based on direct harm is not possible with these data. However, it is also plausible that extended social networks may lead people to learn of harm to others, which this survey cannot capture.

Objective data on weather-related losses in the eight countries under investigation are in the International Disaster Database (EMDAT) and the Belgian Centre for Research on the Epidemiology of Disasters (CRED), accessible at Prevention Web (2015). As the category classes of EMDAT and the ISWS hazard list have fewer than 50% common items, no statistical comparison is made here.

5) Recent loss effects

A month before our U.S. survey in Oklahoma City, an EF5 tornado struck Moore, with 24 fatalities. To account for the situation, respondents were asked whether the event affected someone in the family or someone personally known. A chi-square analysis showed no significant differences between 22 affected and 77 unaffected people for the main ISWS items. In the U.S.

TABLE 2. Subjective risk of meteorological hazards (10-point Likert scale: 0 = no, 10 = high risk), means (highest three ranks in brackets).

	India	Brazil	Germany	Israel	Malaysia	Poland	United States	Australia	$N = 812$
Hurricane/severe storm	5.1	7.8	7.6 (3)	3.6	5.8	7.3 (1)	3.9	4.1	5.5
Heat	3.7	6.1	4.5	6.7 (1)	8.0 (1)	5.8	6.9 (3)	6.6 (1)	6.1 (2)
Landslide	7.6 (1)	8.9 (2)	6.2	4.1	6.7	4.0	2.9	3.7	5.5
Hail	3.9	6.8	6.7	3.4	4.7	5.1	7.4 (2)	5.3	5.3
Tornado	4.4	7.4 (3)	8.1 (1)	3.7	4.9	6.8 (3)	9.2 (1)	4.4	6.0 (3)
Flood	4.4	9.1 (1)	7.8 (2)	5.3 (3)	7.4 (2)	7.1 (2)	6.4	6.4 (2)	6.7 (1)
Avalanche	3.2	5.9	6.4	3.2	3.2	5.5	2.8	3.1	3.9
Lightning	5.2 (3)	7.4 (3)	5.5	4.1	7.2	6.1	6.6	5.7 (3)	6.0 (3)
Snow	2.0	2.9	5.3	4.5	2.7	5.5	6.5	3.5	3.9
Rainfall	5.6 (2)	7.1	5.1	5.2 (2)	7.4 (2)	4.8	5.7	5.4	5.8

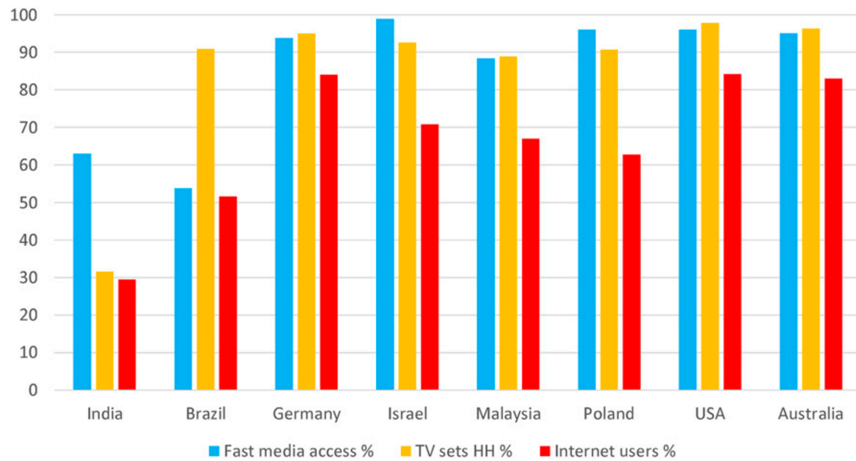

FIG. 7. ISWS samples fast media (TV, radio, internet) access, TV sets in household population, and internet users population in percentages. TV set(s) percent per households from Nationmaster 2014 (http://www.nationmaster.com/country-info/stats/Media/Households-with-television); Internet users percent from International Telecommunication Union Yearbook 2012 (www.unicef.org).

sample, tornadoes had the ISWS maximum risk mean (9.6), so perception and preparedness are vital for everyone there, not only for people recently affected by tornadoes.

6) Risk preparedness

Local subjective risk preparedness displayed the following structure (Fig. 9): 91% of U.S. respondents reported to be "fully informed," compared to fewer than 15% in Brazil. Intersample variance was high for "fully prepared," with 63% in the United States and only 7% in Brazil. Most of the samples had low self-reported full home insurance rates under 30% (maximum: United States 59%; minimum: Brazil 3%). From Austrian surveys, it is known that laypersons typically have marginal knowledge of whether they are fully insured and in detail for what hazard, so the ISWS replies likely do not tell the truth about the level of coverage but reflect subjective safety and overconfidence on the part of survey participants. Similar to the knowledge score, preparedness should be studied more in depth and operationally (i.e., what safety features are present at home?) instead of a personal feeling of preparedness.

7) Weather fear and gender difference

Fear is the emotional response to real or perceived imminent threat, whereas anxiety is the anticipation of future threat (APA 2013). The ISWS screening instrument had

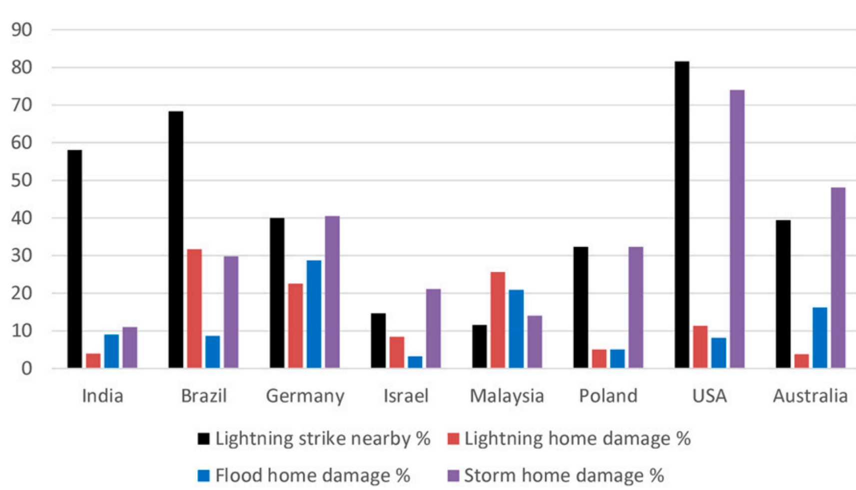

FIG. 8. ISWS frequency of experienced close lightning and loss/damage, as sample percentages.

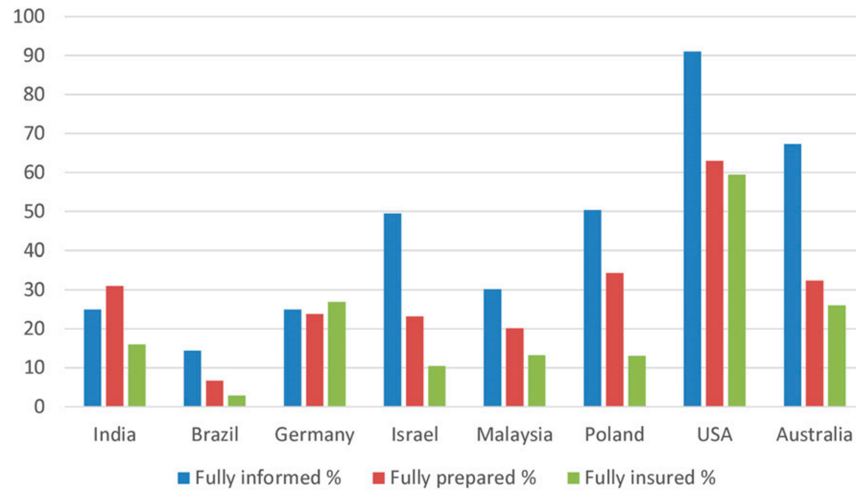

FIG. 9. ISWS risk preparedness, sample percentages.

no room for special clinical items and used one item on self-reported weather fear (no fear, fear at times, strong fear). In this context, reality-oriented fear (of possible imminent danger) and phobic fear [out-of-proportion fear of a specific object or situation, APA (2013) diagnostic criteria for specific phobia] were expected to be identified. In Fig. 10, fear at times (with nearby danger) was highest in Australia (71%), the United States (68%), Israel (64%), and India (61%) and was lowest in Malaysia (36%). There were no data for this category in the Brazilian sample. Strong weather fear, including phobic fear, was reported highest in Malaysia (60%) and least in Germany (4%). Fear at times and strong fear are not proportional in the samples. As we have no qualitative data about the drivers of this fear, it is not possible to speculate on the differences. The Malaysian mental health survey (Krishnaswamy et al. 2012) suggested that 0.5% of the sample ($N = 3666$) had phobias, which is lower than the international prevalence level of a systematic review by Somers et al. (2006).

A chi-square test about gender and weather fear in the ISWS database produced $\chi^2 = 31.78$ with $p < .001$, that is, a highly significant difference. In the high-fear category, 17.4% of women and 9.8% of men were present. However, we must again distinguish between reality-oriented fear and phobic out-of-proportion fear. A meta-analysis of 72 studies of sex differences in sensation-seeking found a mostly stable female risk aversion over time (Cross et al. 2013). Furthermore, Barlow (2002) mentions higher female lightning fear and that, relative to women, men underreport their fears. The APA (2015) states in a report about anxiety disorders measured with the clinical instrument DSM-5 that females are more frequently affected than males, at a rate of approximately 2:1, although rates vary across different phobic stimuli. This suggests that this difference is unsurprising within the ISWS dataset and appears to indicate little variation between the cross-cultural samples.

c. *Inferential statistics (Pearson correlations, regression analysis)*

To analyze interrelations and evaluate the range of results from the available sample, inferential statistics were calculated using IBM SPSS statistics. Twenty-two Likert-scaled ISWS questionnaire items were summed up to five different scores (see section 2b for item numbers in the questionnaire): the risk score (10 subjective risk items, 11-point Likert scales, sum 0–110), the interest score (two weather interest items, 4-point Likert scales, sum 2–8), the basic meteorological knowledge score (four items, sum 4–8), the preparedness score (three items, 3-point Likert scales, sum 3–9), and the hit score (three damage/loss items, sum 3–9).

To test whether the score transformations provide representative and internally consistent samples, Cronbach's α (alpha) was computed. It is a statistical measure of scale reliability and internal consistency that determines how closely related a set of items are as a group. Cronbach's alpha is defined as the number of items multiplied by the average interitem covariance among the items divided through the average variance plus $N - 1$ multiplied with the average interitem covariance. Increasing the number of items increases Cronbach's alpha. As the average interitem correlation increases with a constant number of items, Cronbach's alpha also increases (Cronbach 1951). As a rule of thumb in reference for empirical research, scores with a Cronbach's α less than 0.70 are considered less reliable, while a score under 0.50 is unacceptable (Cortina 1993). For the SPSS item analysis of the $N = 812$ ISWS dataset, the risk score (10 items) produced a Cronbach's α of

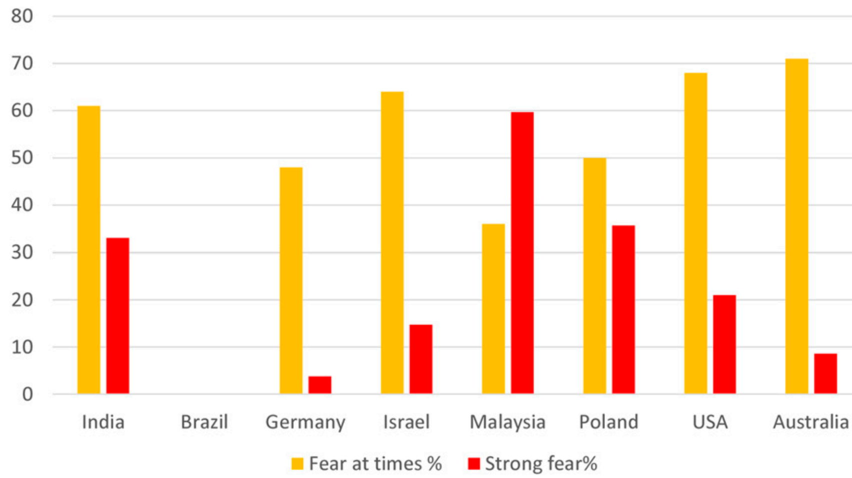

FIG. 10. ISWS reported weather fear (at times and strong), sample percentages.

0.87, the weather interest score (two items) a Cronbach's α of 0.69, the basic meteorological knowledge score (four items) a Cronbach's α of 0.62, the preparedness score a Cronbach's α of 0.58, and the hit score a Cronbach's α of 0.57. This suggests that the internal consistency of the risk score is excellent, and the reliabilities of the other four scores made up by more heterogeneous items are still within acceptable tolerances.

The risk score means had a range among the countries of 44–69, with the Brazil sample as the maximum and the Israel sample as the minimum. The weather interest score (range 3.5–5.2) mean was highest for the United States and lowest for Israel. The basic meteorological knowledge score (range 4.7–7.5) mean was highest for Germany and lowest for India. The preparedness score (range 4.1–7.5) mean was highest for the United States and lowest for Brazil. And the hit score (= damage/loss; range 7.9–8.7) mean was highest for the United States and lowest for India and Israel. While in-sample inferences between the respective cultural analyses would be ideal to assess whether these differences were within individual sample variance, the large variation in the individual country demographics and sample size variation limits the statistical power of conducting this analysis. Preliminary analysis prior to pooling identified no distinguishable, large, statistically significant differences in the score variance among the different country samples, which is unsurprising, given that the samples were limited to a sample size of approximately 100 for each country. Future analyses of larger samples would likely warrant investigation of country-by-country within-sample variance.

1) Pearson correlations

To test for connections of the hit score (damage/loss), six sociodemographic and six psychological weather-related items (for their arrangement, see again the lens model in Figs. 1 and 2) and Pearson correlations were computed for the 13 respective items/scores. As the resulting 13 × 13 correlation matrix is an intricate pattern, a selection of nine main items, including the five scores, is shown as Fig. 11. Highly significant p values of Pearson r correlations ($p < 0.001$) are printed as black boxes. Because of the sample size of $N = 812$ and the potential for a result to be obtained by random chance, less than highly significant correlations are not discussed. For the nominal variable of gender, chi-square tests were computed to control the Pearson's r values. The three significant effects were confirmed.

Interpreting Fig. 11 results, psychological variables (fear, interest, knowledge, and preparedness) all interrelate strongly. Only fear and preparedness show highly significant correlations with risk (the subjective risk assessment score). The reported hit/loss score (lightning, flood, storm) is strongly related to knowledge, interest, and the preparedness scores. Summing up, the interaction of psychological weather-related items is intense, but interest and knowledge do not interact with the subjective risk assessment, and fear does not interact with prior hit/loss experiences. In this respect, the exploratory study has found that the network of relations among these factors is complex and cannot be represented (and also changed) by few central connections.

2) Regression analysis

Testing multivariate regressions, dependent variables (criteria) and several independent variables (predictors) were assessed. As with the correlation analysis, cautious inferences are possible, but the statistical results based on the sample obtained do not support causal relations. Here, we explore the potential multivariate relationships

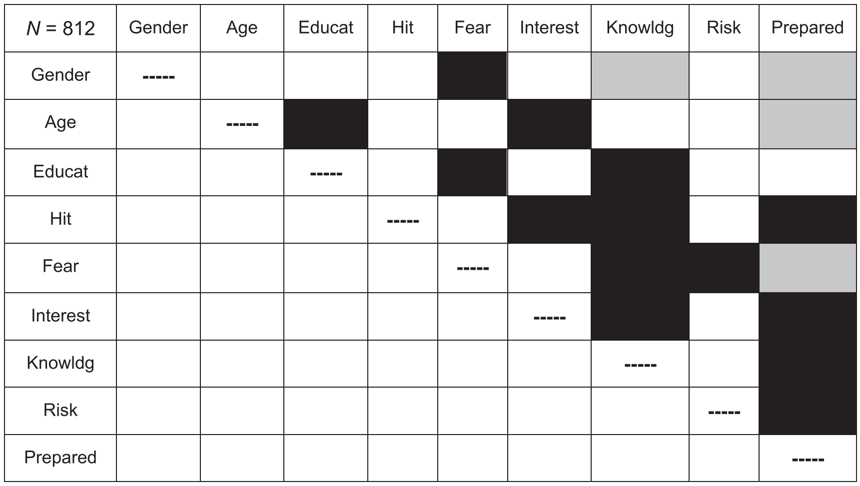

FIG. 11. Selected significant Pearson correlations of sociodemography (gender, age, and education) and hit score (loss/damage) and psychological variables (fear, interest, knowledge, risk, and preparedness) of the ISWS sample $N = 812$. Interest, knowledge, risk, hit, and preparedness are scores. Highly significant correlations ($p < 0.001$) are displayed as black boxes; significant correlations ($p < 0.05$) are shadowed.

on the pooled dataset to assess the potential for future analysis with larger samples, as individual country samples had insufficient type categorizations to form representative and statistically sound regressions.

In the Brunswikian lens model (see section 2a and Fig. 2) for the process leading from objective hazards to subjective risks, the distal objective elements are the hazard/risk, actual physical damage/loss (hit score), and sociodemography (gender, age, education, children, and housing type). As objective hazard/risk information is not available for all weather elements and survey locations, it is not introduced in the model applied here. Elements on the proximal subjective side of the model are psychological variables (weather knowledge, interest, and fear), subjective risk, and personal preparedness. The preparedness score (which includes completing insurance, taking preparatory actions, and gathering information) was interesting from a psychological perspective because it is self-reporting actual behavior (not only knowledge or beliefs) of participants in the study. For this reason, preparedness was selected as a dependent variable for the regression calculation in order to find possible predictors for this behavior by a stepwise regression method. Twelve variables were used as independent variables in the regression model: hit score (past damage), psychological variables (basic meteorological knowledge, interest, fear), subjective risk score, sociodemography (gender, age, education, housing type, number of adults and children in the household), and access to local weather reports. For this SPSS stepwise regression model type, categorical/nominal predictors had to be transformed into dichotomous variables (via ‘‘dummy coding’’; Field 2013).

To get robust regression estimates, the resampling method of bootstrapping was also applied (Efron and Tibshirani 1993). Bootstrap samples are sampled with replacement, and the process produced a large number (1000–10 000) of nonidentical samples. The results were tested for possible multicollinearity, as highly related predictors interfere with the regression coefficients, with the variance inflation factor (VIF) as the criterion to assess this potential (IDRE 2017).

The regression analysis showed highly significant results after seven steps with adjusted $R^2 = 0.24$, $F(7, 525) = 24.36$, $p < 0.01$ (see Table 3). Final significant predictors were interest score; housing type: detached house; gender: male; housing type: high-rise building; hit score (damage); education: high school graduation; and availability of local weather reports. VIF values close to 1 indicated no relevant multicollinearity among the factors.

In the idealized Brunswikian lens model, relevant regression results link preparedness with experienced damage/loss (hit score), the subjective risk score, sociodemography (gender, housing, education), and the psychological variable interest. This suggests that weather hazard preparedness is a multivariate process, with experienced loss, subjective risk, interest, gender, education, and housing type as constituents. Because of the infrequent loss experiences in a lifetime, the nature of the nonrepresentative obtained samples from individual countries, and a lack of meteorological training even after

TABLE 3. Stepwise linear regression analysis: beta (Pearson's *r*), *t* values, and VIF (collinearity statistics) of individual predictors for the criterion variable preparedness.

Predictors	β	t	VIF
Interest score	0.25**	5.81	1.05
Housing type: detached house	0.19**	3.92	1.36
Gender	−0.17**	−4.10	1.03
Housing type: high-rise building	−0.17**	−3.62	1.33
Hit score (damage)	0.12**	2.84	1.04
Education: high school graduation	0.11**	2.59	1.02
Availability of local weather reports	0.09*	2.19	1.02

** $p < 0.01$
* $p < 0.05$

higher education, information provided by weather services and mass media can promote weather interest, especially when the information has everyday relevance, is gender balanced (United Nations General Assembly 1997), and is provided repeatedly at the right time, that is, juxtaposed with severe weather incidents.

Finally, a univariate linear analysis of variance (ANOVA) was performed, checking for differences in preparedness among the transcultural samples. It showed highly significant differences among the samples [$F(7, 804) = 56.27, p < 0.01, \eta^2 = 0.33$]. The results are presented in Fig. 12, where the dependent variable preparedness was standardized (i.e., z transformed with a mean of 0.0 and a standard deviation of 1.0) for better visualization. The samples with the highest preparedness scores come from the United States and Australia, while the lowest came from Malaysia and Brazil, which suggests that there are large transcultural differences in preparedness that may be related to demographic factors both considered and neglected in the ISWS survey.

4. Conclusions

Interdisciplinary studies of multiple weather hazards in transcultural perspective have been infrequent within the literature, suggesting that additional analysis is needed to understand transcultural differences. However, empirical sampling methodologies and appropriate survey instruments remain in an experimental stage, without a sufficient sample to obtain truly representative cross-cultural comparisons or draw conclusions on the most effective analysis techniques. Important factors to consider for future studies include an appropriate theoretical basis for the sampling and demographic data obtained and to ensure that the distinction between variables is clear for survey participants, especially following translation of survey instruments. This points to the need for an interdisciplinary team of both natural and social scientists, as was the case in the ISWS survey. Important differences were noted between the country samples for the quality of severe weather information for laypeople, influencing weather knowledge and thereby potential fears and preparedness. The social boundary conditions with regard to weather knowledge and weather information are similar in different countries in that there exists no formal meteorological training for laypeople, even academics, and the transient and stochastic character of severe weather hazards does not allow trial-and-error learning for the individual, so the communication of weather services via mass media becomes important. Media weather information is not encountered in a school learning situation but in an everyday context with distraction, so either a short individual message is distilled—detailed or general, correct or incorrect—or the media information fails to have an effect.

A number of limitations were identified in the sampled data. The descriptive data analysis showed local urban samples in all eight countries, four in metropolitan areas. This suggests that the ISWS presented here lacks a representative description of rural areas or regional differences within countries. Furthermore, five samples show an educational bias, and thus, the results presented here also do not represent less educated segments. These limitations suggest that care must be taken for future cross-cultural multihazard analyses when samples are collected by different investigators to ensure random or representative sampling and appropriate quotas are obtained in line with the study goals. Ideally, such future analyses would also consider a wider gamut of regions within the individual countries, providing a more representative sample. However, as the local probability of meteorological hazards varies considerably even within individual countries, tailoring sampling to meet research questions and including a wide variety of potential exposed communities would be necessary.

For the sample here, based on 10 meteorological hazards, the highest subjective risk means were flood, heat, tornado, and lightning, with appropriate subjective risk rankings and countries illustrated (Table 1). The comparatively rare loss experiences were mostly moderate losses, limiting the individual learning effect in improving both weather awareness and preparedness. Subjective risk preparedness (i.e., with the risk of overconfidence), tested by an ANOVA, showed significant differences from U.S. to Brazil respondents, though demographics were insufficient to determine the casual link for this feature. Like weather knowledge, it is important that subjective risk preparedness be tested by practical questions. Self-reported weather fear was also

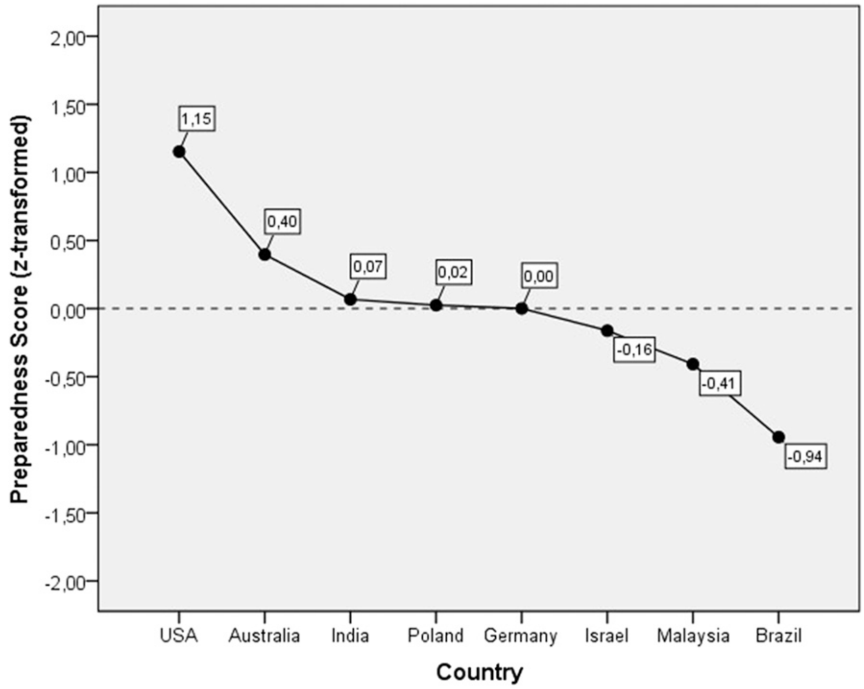

FIG. 12. Univariate linear analysis of variance: Z-transformed (standardized) preparedness scores, sample means.

found to correlate with education and gender, with female participants generally reporting greater concern regarding environment hazards, in line with prior analyses. These results suggest the need for additional qualitative research, as the expressed fear could be further segregated as either realistic or phobic. With the exception of India, access to fast media (TV, internet) within the cross-cultural samples was high, but the legibility of media weather reports showed room for improvement, as did the access to local weather information, particularly in Germany. There was considerable uncertainty in the need for media weather reports to provide advice regarding necessary safety measures, with polarization among the various sample countries, ranging from a low need in Germany to a high need in India.

A bivariate and multivariate statistical analysis tested for significant relations of the main variables. With respect to the subjective preparedness, experienced loss, subjective risk, interest, gender, education, and housing type were identified as important predictors for the pooled dataset. Looking forward, future studies with larger in-country samples are necessary to perform a more detailed cross-cultural analysis. A key limitation to this analysis is that the analyzed material was self-reported and retrospective. Since mental reflection of weather risks "in fair weather" is different from perception and action under real danger, we agree with Morss and Hayden (2010) that further empirical studies of how intended audiences obtain, interpret, and use forecasts and warnings are needed to provide valuable knowledge that can help design more effective ways to convey severe weather risk.

Based on the results presented, it is the authors' opinion that this exploratory survey provides an important framework for future analyses and elucidates limitations in the sampling and analysis methodology that will be beneficial to future cross-cultural multihazard perception studies. The multihazard survey instrument, with its five translated versions, worked in the field and led to statistically sound results within the sampling limitations. Several items (e.g., the weather fear item, inclusion of additional meteorological hazards) require special attention and further development in future work. The ISWS questionnaire was able to depict local particularities (e.g., different needs with regard to the weather report caused by cultural and educational differences), as well as overarching similarities that have been noted for single country surveys (e.g., higher concern for severe weather hazards for female participants). With larger and more representative ISWS samples in the future, the stability of the statistical results presented here (e.g., the preparedness regression) could be assessed and a more granular assessment of the characteristics of these factors between countries performed. ISWS elements or the whole set of items can be further used to monitor weather-related psychological orientations, particularly of sensitive, vulnerable population groups (Peek and Mileti 2002; Ebi et al. 2006). As an example of ongoing work in this direction, an extended general population survey including rural sampling is already underway in northeastern India.

Acknowledgments. The authors want to thank the 812 laypersons of the ISWS survey for their friendly cooperation. The ISWS survey won the Heino Tooming Award 2015 by the European Severe Storms Laboratory (ESSL), which also covered parts of the first author's support for fieldwork in three locations. Motivated by the aim to provide a template for future studies, the survey items (see appendix) and their translations are free for scientific use in possible replications and new projects. We request that further results be communicated to the first author in return for utilizing this survey. A supported Brazilian survey was done by L. H. Nunes and M. L. de Benini of Campinas University, who left the authors' team in 2013. We are thankful for detailed peer reviews by three experts who led us to structural improvements and enhancement of the paper.

APPENDIX

The ISWS Risk Perception and Preparedness Questionnaire

English version of the main survey items (copyright Alexander G. Keul 2016).

Portuguese, Polish, Hebrew, Bahasa Malaysian, and German versions are available.

Q1. Do you personally take an interest in daily weather?
Yes, always/Yes, often/Sometimes/No, not at all

Q2. Are you weather-exposed in your daily life?
Yes, always/Yes, often/Sometimes/No, not at all

Q3. Do you follow the daily weather report(s) in the media?
Yes, always/Yes, often/Sometimes/No, not at all

Q4. Where do you get your daily weather information? (please mark the most important sources)
Newspaper/ Internet/Radio/Television/Family/ Other: …………….

Q5. Is the speed* of the weather report in radio/TV OK for you? (*speaking tempo)
Yes/Not always/No

Q6. Can you easily get your local weather from radio/ TV reports?
Yes/Not always/No

Q7. Should media weather reports give more precautions?
Yes/Only in severe danger/No

Q8. How important are the following media weather forecast time intervals for you?
Give each of them a number between 10 = very important and 0 = not important at all
The next hours/The long-range trend/For tomorrow/ The trend for 4 to 7 days/The trend for 2 to 3 days

Q9. How dangerous do you think are any of the following severe weather phenomena <u>for you</u>?
Give each of them a number between 10 = very dangerous and 0 = not dangerous at all
Hurricanes/Cyclones/Heat/Drought/Landslides/ Hail/Tornadoes/Floods/Avalanches/Lightning/ Snow/Ice/Cold/Heavy rainfalls

Q10. Where do you get up-to-date warnings on severe weather? (Please mark most important sources.)
Newspapers/Family/Radio/Internet/Friends/Work place/Television/Local alarm/siren/MET Office/ Other

Q11. Areas called "high"/"low" on the weather map:
Are hotter/colder/Are more windy/calm/Have different air pressure/I do not know

Q12. Do you know different cloud types?
Yes/No.
Give an example: ………………………

Q13. A cold front is:
A hailstorm/The border of a cold air mass/Cold air going downhill/I do not know

Q14. A tornado is:
A sudden wind gust/A type of thunderstorm/A damaging whirlwind/I do not know

Q15. Are you personally afraid about severe weather?
Yes, very/At times/No, never

Q16. Do you feel well-informed about severe weather?
Generally yes/At times/No, never

Q17. Do you feel personally prepared for possible risks of severe weather?
Yes/Partly/No

Q18. Do you hold an insurance for risks of severe weather?
Yes, for most/For some/No

Q19. When three seconds pass between a lightning flash and its clap of thunder, this lightning flash had a distance of ………. kilometer(s) / ………. miles from my own position.
Following: Twelve lightning statements from lightning questionnaire, each: Yes/No/I do not know (Note: These questions were not used for the ISWS analysis presented here)

Q20. Did you ever see a nearby lightning strike?
Yes, several times/Yes, once/No

Q21. Was your home ever hit by lightning?
Yes, severe damage/Yes, moderate damage/No

Q22. Was your home ever hit by a flood?
Yes, severe damage/Yes, moderate damage/No

Q23. Was your home ever hit by a storm?
Yes, severe damage/Yes, moderate damage/No

Ten sociodemographic items were also solicited: gender, age (years), profession, household size, number of household children, town, federal province/state, house type, education level, and rescue organization/training.

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