Short Communications

Epidemiology at the Bar: A Legal Proof on Causation with Cancer Epidemiological Results

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Abstract

　The development of natural science has revealed causal relationships that we did not know about through scientific hypotheses and verification. Therefore, given enough time, the causal relationship between the controversial toxic substances and disease outbreaks will be largely elucidated. However, in the courtroom, the judge cannot wait for that moment, and must make a legal value judgment on the causal relationship as a condition for establishing a tort. In other words, the responsibility for who will compensate for the actual damage must be attributed to which party. This study examines the evidence of epidemiological findings in today's risk society. In particular, we deal with cases where there is no way to prove a causal relationship other than epidemiological data in a lawsuit for compensation for damages caused by harmful substances such as cigarettes. This study seeks to find a way to appropriately evaluate the value of evidence by correctly interpreting and rationally utilizing the results of epidemiological studies in court through a pragmatic pluralistic approach.

Keywords: Cancer Epidemiology- causation- legal Proof

Introduction

　Epidemiologists make estimations about causal relationships between risk factors and diseases. However, they only state that a particular factor can lead to a particular disease and do not speak of which factor has actually caused the plaintiff's disease. In lawsuits for damages, the causal relationship regarding the substance to which the plaintiff has been exposed and the disease from which he or she consequently has come to suffer, or a causal relationship, in the legal sense, is something that judges must determine. If so, then, can judges infer legal causation from epidemiological causal relationships? Once an epidemiological causal relationship between a harmful substance and a disease has been acknowledged, is the causal relationship between specific exposure to the harmful substance and the development of the disease on an individual level also considered to have been proven? In Japan, in cases where an epidemiological causal relationship has been proven, legal causation is determined to exist between the harmful substance that has caused the disease in question and the development of the disease. For example, in a ruling that acknowledged a causal relationship between chromium VI (Cr6) contamination at workplaces and lung cancer among workers, the court stated that statistically significant figures had already been confirmed according to the results of epidemiological investigations and that Cr6

could be asserted conclusively as a carcinogenic substance according to animal experiments and genetic toxicity experiments as well. Therefore, it was ruled that there clearly existed a causal relationship between occupational exposure to Cr6 and liver cancer in the lawsuit. However, epidemiology is a discipline that studies populations and the correlations between particular factors and diseases, and epidemiological research results fundamentally consist of statistics on populations (Hall and Silbergeld, 1983). In general, it is inappropriate to make statistical inferences on individuals from research results concerning entire populations (Jurs, 2009; Greenland et al., 1999). For example, when the statistics that 70% of balls in an opaque box are red have been obtained from the results of sampling surveys, it cannot be said that the probability of the color of a ball taken out from the box and hidden in the hand being red amounts to 70%. The ball will be either blue or not. Even when the probability of the existence of a causal relationship between exposure to a particular risk factor and the development of the disease in the plaintiff is judged to be 50% based on an epidemiological study where the RR has been observed to be 2.0, the existence of a causal relationship in the legal sense cannot be stated based solely on this. Although it is commonly used in the natural sciences, probabilistic causal inference is an argument far removed from traditional legal principle regarding fact-finding. Major facts that courts acknowledge either exist or do not exist. This is because

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the possibility for the existence of a particular fact amounts to either 100% or 0%, not 30% or 70%.

Legal Proof on Causation with Epidemiological Results

It is still difficult for courts to make inferences about individual legal causation from epidemiological causal relationships. Nevertheless, it is excessive to claim that epidemiological research results cannot be used as evidence to prove legal causal relationships. Some believe that epidemiological research results can be used only as evidence to disprove the other party, not as evidence to prove requisite facts for the establishment of a liability for compensations (Jaffee, 1985). However, only the competence of evidence is called into question in civil lawsuits unless there are special circumstances, and this is dependent on judges' free evaluation of the evidence. Here, although judges must respect scientific facts or already proven probability, they do not necessarily have to exclude something just because it does not constitute generally approved scientific knowledge. This is because science and trials belong to fundamentally disparate time frames. Because science is a discipline that arrives at the scientific truth through hypotheses and verifications, given adequate time, the causal relationship between a particular harmful substance and the development of a particular disease will become clear in terms of the natural sciences. Until that moment, the hypothesis regarding the existence of a causal relationship will maintain its status as a still unverified hypothesis. However, judges do not have the time to wait. In determining causal relationships as constituent elements of wrongful conduct, the South Korean Supreme Court has made legal value judgments on the level of who is responsible for compensations for damages that have actually occurred. According to this legal principle, determining the competence of evidence of epidemiological research results in courts ultimately leads to the question of which elements are to be taken into consideration. Matters that must be taken into consideration to reduce errors and to determine the competence of evidence correctly in applying epidemiological research results in courts are as follow. First, the study in question must be one conducted by authoritative epidemiologists using reliable methods (Dore, 1983). In addition, because the competence of evidence is higher for cohort studies than it is for case-control studies, judges must evaluate the results of appraisals by experts considering the differences in research methods. Second, errors due to chance, biases, or confounders must be controlled appropriately (Federal Judicial Center, 2011). Even though epidemiologists strive to reduce them at the study design, data collection, and data analysis stages, errors inevitably occur. Judges must bear this in mind when examining the epidemiological figures submitted as evidence and determining their reliability. Third, the RR derived from epidemiological research must reach a certain level. In American judicial precedents, legal causation has been seen as acknowledgeable only in cases where the RR is 2.0 or above or the attributable risk (AR) is 0.5 or above (Egilman et al., 2003; Black and Lilienfeld,

1984; Green, 1992). On the other hand, in Japan, for "high probability," which is the degree of proof in the Code of Civil Procedure, the AR is seen as amounting to 80% or above. The AR can be converted into the RR. Because $AR=(RR-1)/RR$, when the AR is 80%, the RR must be 5.0 or above. However, this confounds the probability of the existence of a causal relationship and the degree of the judge's conviction regarding the existence of a causal relationship, or the degree of proof. Of course, nor can it be stated with certainty that the existence of causal relationships in individual cases is negated just because the RR remains on or below a certain level. However, when epidemiological research results constitute the only evidence, the lower the degree of the association is, the more cautiously individual causal relationships must be acknowledged. Fourth, the qualitative and quantitative homogeneity must be acknowledged between the risk factor to which the plaintiff allegedly has been exposed and the risk factor determined by epidemiological research results. The degree, duration, type (exposure at home or the workplaces), and method of exposure determined by epidemiological research must be identical to those claimed by the plaintiff (Dore, 1985). Fifth, the plaintiff must be identical to members of the general population in terms of exposure to possible risk factors other than the one in question. For example, when people who have smoked half a packet of cigarettes a day for 20 years are selected as members of the exposed group for a study on the association between smoking and lung cancer, the research results cannot be applied to a plaintiff who has smoked one packet of cigarettes a day for 30 years. In general, when individuals who belong to the group studied differ from one another in the degree of exposure to risk factors besides the one in question, the RR obtained from the research results is only the average risk for that group and cannot be applied categorically to individuals belonging to it. Sixth, the possibility of the development of the plaintiff's disease due to causes other than exposure to the factor in question must be excluded. If none of the research participants has a family history of cardiac disorders in a study on the association between smoking and cardiac disorders, the fact that genetic factors cannot cause lung cancer must be proven first in order to be able to apply those research results to a plaintiff with a family history of cardiac disorders.

Legal Proof on Causation without Epidemiological Results

To prove causal relationships, scientific evidence including animal experiment or in vitro experiment results and case reports is submitted at times in addition to epidemiological research results. Although such data, too, can be used as evidence to prove causal relationships, their advantages and disadvantages must be understood adequately when determining their value as evidence (Green, 1992; Egilman et al., 2003). Because animal studies are experimental studies instead of observational studies, the researcher can control the research environment and therefore reduce the possibility

of biases that affect the results. In addition, dose-response relationships can be determined with certainty because the amounts of the risk factors to be administered to animals are adjustable. Another advantage is that the research time is reduced because animals have short life spans and reproduction is easy to accomplish with them. In contrast, due to interspecific differences (i.e., sizes, life spans, metabolism), it is difficult to say for certain that the effects identical to those found in animal study results will occur in humans as well (Green, 1992). In addition, the presence or absence of a threshold effect, too, must be examined because the animals studied are exposed to the risk factor in question adequately to cause the disease in question in animal studies (Egilman et al., 2003). Consequently, in order to acknowledge the validity of animal study results, whether the animal selected is appropriate must be reviewed according to the harmful substance to be studied and its effect, and the animal's pathogenic resemblance to humans. In vitro experiments consist of laboratory tests of the biochemical effects of a particular factor on cells, bacteria, tissues, and embryos. An example is transplanting animal embryo cells, exposing them to a substance that causes deformities, and testing their effect on grafted tissues. Although inexpensive, these experiments are conducted in animals and therefore do not take into consideration the effects of the factor in question on pregnant human mothers and human placentae (Green, 1992). Case reports can also help to establish causal relationships conclusively. This holds true when reports on the side effects of a particular drug are published in academic journals or recorded in the database of the South Korean Ministry of Food and Drug Safety (MFDS). However, case reports may originate from chance rather than reflect true causal relationships. Nevertheless, when the effect of a particular risk factor is strong, a causal relationship is established based on case reports alone.

Tobacco Lawsuit Cases in Korea

The Korean National Health Insurance (NHI) system is operated by the National Health Insurance Service (NHIS) under the supervision of the government and provides health security based on Bismarckian social insurance principles (Lee et al., 2008; Kim, 2010). NHI in Korea is compulsory and is a universal social insurance program that covers the entire population. The single insurer, the NHIS, has improved the equity of insurance contributions and the efficiency of managerial operations by converting a society-based corporatist system with multiple insurers into a unified managed system (Kim & Lee, 2010). South Korean men's smoking rates are high among member states of the Organization for Economic Cooperation and Development (OECD), and the ensuing cancer incidence rates and cancer mortality rates are considerable as well (Park et al., 2014). In addition, the national healthcare expenses used to treat various diseases caused by smoking, too, are on an immense scale. To suppress all of this, several cancer patients filed a lawsuit against tobacco companies both at home and abroad, claiming compensation for damages based on

a causal relationship between smoking and lung cancer emergence, but was rejected by the Supreme Court of South Korea. When diagnosed with non-small-cell lung carcinomata and bronchioloalveolar carcinomata, which are types of lung cancer, A, with a smoking history of 30 or more pack years, and B, with a smoking history of 40 or more pack years, filed the present case against parties manufacturing and selling tobacco including the state, claiming compensation for damages. The Supreme Court ruled that the original judgment, which had not acknowledged a causal relationship between A's and B's smoking and their development of lung cancer, was justified. When examined more closely, the main points of the Supreme Court precedent are as follow.

Generally, those who make and sell products must manufacture products having safety within an expectable range in their structures, quality, and performance in reflection of current technological levels and economic feasibility and become liable for compensation due to illegal acts if and when damages arise to users due to defects in products stemming from the failure to secure such safety. From among such defects, important are the so-called design defects, which mainly consist of cases where products fail to be safe because manufacturers have not adopted reasonable alternative designs and therefore have failed to reduce or avoid damages and risks. Consequently, the South Korean Supreme Court has judged whether products have design defects both in consideration of diverse aspects including the characteristics and usages of products, contents of users' expectations of products, contents of expected risks, users' perception of risks, possibility of risk aversion by users, possibility and economic costs of alternative designs, and relative advantages and disadvantages of adopted designs and alternative designs and in reflection of socially accepted ideas.

In the present case, where the presence or absence of design defects in tobacco manufactured by parties including the state became the issue, the South Korean Supreme Court ruled that even if there were methods by which parties including the state could eliminate nicotine or tar completely, these parties' failure to adopt such methods could not in themselves be seen as design defects in reflection of points including the following: burning strip-leaves and inhaling the smoke were the essential characteristics of tobacco use; the flavor of tobacco changed according to the amounts of nicotine and tar, and tobacco consumers selected and smoked tobacco products that had flavors or aromas to their liking; and tobacco consumers smoked with the intention of obtaining the medicinal effects of nicotine such as a sense of stability or security. In addition, the Court upheld the original judgment, which had not found design defects in tobacco, because there was no evidence to acknowledge that tobacco companies had possessed but had not adopted reasonable alternative designs capable of reducing damages or risks to tobacco consumers due to smoking.

Of course, the South Korean Supreme Court acknowledged responsibility due to illegal acts regarding warning defects, where parties including manufacturers could have attached but had violated reasonable

explanations, instructions, or warnings, thus reducing or avoiding the possible emergence of damages or risks due to the products in question (Lee, 2016). However, the Court ruled that when the presence or absence of such defects was judged, diverse aspects including products' characteristics, forms in which products are customarily used, contents of users' expectations of products, contents of expected risks, users' awareness of risks, and possibility of risk aversion by users must be comprehensively taken into consideration.

In the present case, where the presence or absence of warning defects in tobacco manufactured and sold by the state became the issue, it is a well-known fact that, through media reports and mandatory (legal) control, the possibility for smoking to cause cancer and diverse diseases in the lungs and respiratory organs is broadly recognized throughout society. However, the South Korean Supreme Court judged not only that the continuation as well as initiation of smoking were issues of choice according to free will but also that tobacco consumers widely recognized the possible difficulty of ceasing smoking once the habit had been initiated. Consequently, the Court supported the original judgment, according to which it was difficult to see tobacco as having warning defects just because parties including the state, tobacco manufacturers, had not attached additional explanations or warnings besides attaching cigarette warning labels in accordance with legal regulations.

When diagnosed with lung cancer after having smoking for a long time, A and B filed the present case against parties that manufactured and sold tobacco including the state, claiming compensation for damages. The South Korean Supreme Court ruled in the present case that a causal relationship could not be acknowledged between A's and B's smoking and their development of lung cancer. As the reasons, the Supreme Court cited grounds such as: lung cancer was not a specific disease caused solely by smoking but was a non-specific disease that could emerge through the complex interactions of external environmental factors including physical, biological, and chemical factors and biomechanical factors; non-small-cell lung carcinomata also included types of lung cancer that had no or very little association with smoking; and bronchioloalveolar carcinomata, a kind of adenocarcinomata, had a very low association with smoking in comparison with squamous cell carcinomata and small-cell lung carcinomata and had high incidence rates even among non-smokers so that they very possibly were due to other causes such as environmental pollutants rather than smoking. Moreover, even if epidemiological causation between smoking and the emergence of non-small-cell lung carcinomata and bronchioloalveolar carcinomata, which were non-specific diseases, could be acknowledged, the Court ruled, it was difficult to assert conclusively that the demonstration of the fact of a particular individual's smoking history and the fact of his or her development of non-specific diseases itself proved the probability of a causal relationship between the two facts.

To this date, cases regarding causation between smoking and cancer emergence have been addressed mainly in North American legal circles only. Consequently, there are many implications among international epidemiologists for the South Korean Supreme Court's recent judgment, which need to be addressed mainly in three aspects (Broadbent, 2015). For the sake of convenience, comments on the points of contention are provided in the order of the main points of the Court's written judgment.

First, the South Korean Supreme Court gave the verdict that, because the evils of smoking constituted a fact already and publicly acknowledged throughout society, tobacco companies did not have a special duty of notice above citizens' awareness of the evils of tobacco. According to South Korea's Product Liability Act, when making products that can cause risks to communities or individuals, manufacturers have a legal obligation to attach warning labels regarding evils that can emerge and to urge users' caution. However, the Supreme Court judged that it was adequate for tobacco companies to warn about the hazards of smoking through warning labels on tobacco packets. In a situation where the evils of tobacco have increased continuously in terms of public health, however, it is implausible that tobacco companies should be exempt from publicizing the ills of the product called tobacco themselves and from participating in such a social atmosphere. In the case of South Korea, tobacco price was increased by 2,000 won from 2,500 won to 4,500 won in January 2015, and the attachment of pictorial cigarette warning labels to tobacco packets has been made mandatory from December 2016 through the revision of the National Health Promotion Act. Though somewhat belated in comparison with the South Korean government's ratification of the Framework Convention on Tobacco Control (FCTC) early on, such measures have been taken on the basis of the social consensus that the implementation of a full-fledged smoking cessation policy is necessary. Consequently, tobacco companies, too, must keenly feel their social responsibility and participate in the policy, especially in consideration of the strong toxicity of smoking and the increasingly low ages at which smokers initiate smoking. Moreover, even if the hazards of smoking are adequately known throughout society, credit for such achievements goes to professions in the field of public health including epidemiologists. In other words, the notification and promotion costs for risky products stipulated by laws including the Product Liability Act hitherto have been burdened mostly by the South Korean academia and government, and, taking advantage of this, tobacco companies engaged in business in the domestic market have been exempt from the health campaign costs that they themselves should shoulder and have obtained even higher rates of return. In its recent sentence, however, the Supreme Court did not hold tobacco companies responsible for such duty for public interest but, instead, drew the line regarding the duty of notice with respect to risks that these companies should assume, thus practically disregarding the many citizens suffering from diverse diseases due to tobacco addiction.

Second, the South Korean Supreme Court stated in its

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recent sentence that because smoking was a non-specific disease, the plaintiff must prove the argument that smoking was the only cause of lung cancer. In other words, the burden of proof was placed on the several cancer patients, the plaintiff. However, the Court's judgment in classifying diseases into specific diseases, due to particular causes, and non-specific diseases, due to multiple causes, seems to be far removed from the opinions of epidemiologists, who are the experts. The widely-accepted theory in the academia today is that the causes of all diseases are fundamentally complex and that specificity is not an overwhelmingly important cause in the causal inference of disease emergence (Rothman, 1976). Of course, the emergence of certain diseases is premised on particular causes, and cases where those causes are not fulfilled can be seen as other diseases (Broadbent, 2009). For example, when Vibrio cholerae carriers exhibit symptoms of diarrhea, it is possible to infer that diarrhea is caused by the cholera germ (Broadbent and Hwang, 2016). Consequently, diarrhea not accompanied by the cholera germ is not indicative of cholera. Citing such an example, the Supreme Court would classify cholera as a specific disease. Even for a specific disease, however, separate demonstration is necessary regarding whether that disease is due to the particular cause in question. In other words, epidemiologically speaking, the possibility of the existence of other causes of diarrhea cannot be ruled out. When hypothetical cases are under discussion, deductive reasoning is used. When explaining the mechanisms of disease emergence in reality, however, it is necessary to take into consideration the multiple causes of disease emergence in addition to an inductive reasoning process. Consequently, consistent research results that the relative risk of developing particular diseases is very high when an individual smokes must be adequately reviewed in law courts as well. If the probability of the emergence of lung cancer is very low for non-smokers but is very high for smokers, a causal relationship in disease emergence must be accepted even for non-specific diseases. The protection of victims can be considered more fairly when the causes of disease emergence are determined based on the results of studies conducted by mainstream epidemiologists instead of intuitive judgments on causal relationships according to the presence or absence of specificity.

Third, the greatest problem that has emerged from the South Korean Supreme Court's recent sentence is an attitude that, while treating the levels of judging scientific and statistical causation and legal causation as separate, denies epidemiological evidence regarding the relationship between tobacco and lung cancer emergence in law courts. Of course, the majority of legal literature has addressed how difficult it is to have causation acknowledged in individual-level cases based on statistical evidence concerning populations (Broadbent, 2011; Wright, 2008; Gold, 1986). Consequently, it is difficult to view the Supreme Court's stance as peculiar because of its recent judgment. Nevertheless, it is deeply regrettable that, amidst an increase in similar lawsuits, the Court did not cite epidemiological evidence even in its recent sentence. Not all fields of jurisprudence disregard statistical evidence, and those including forensic medicine

have a considerably wide scope in acknowledging such evidence. Considering these facts, the Supreme Court's recent judgment can be seen as the product of a lack of understanding of specifying causal relationships based on epidemiological evidence.

According to the position of mainstream epidemiologists, epidemiological evidence must be applied to legal judgments in tobacco lawsuits for the following reasons (Broadbent and Hwang, 2016). Let us hypothesize that, in a certain population, there is a male smoking group whose members have smoked 20 or more cigarettes per day for over 30 years. In addition, if these members' relative risk of developing lung cancer is calculated to be 20 in comparison with that for non-smokers, the excess fraction of the smoking group's risk of developing lung cancer is 1 - (1/20) = 19/20, or 0.95. This highly probable figure is obtained after adjusting the diverse sociodemographic characteristics of the individuals to be considered. Consequently, if lung cancer patients emerge from the smoking group after 10 years, it is possible to infer that the cause of the disease lies in smoking. It is because when calculations are made based on the figure above, the probability of smokers randomly sampled not from the lung cancer patient group but from the control group developing lung cancer only amounts to 5%. This is identical to the probability when smokers not belonging to the excess fraction of 95% are selected. Of course, because the etiological fraction can be greater than the excess fraction, smoking can be a contributable factor of lung cancer emergence (Greenland & Robins, 2000). Consequently, a causal relationship between smoking and lung cancer cannot be immediately proven through randomly selected particular cases. In other words, because epidemiological evidence only tracks the eventual differences between disparate groups, epidemiological evidence cannot be used to derive equations for obtaining causal probability. However, if differences between the two groups in incidence rates arise from smoking exposure, then it is possible to infer from numerous cases that the act of smoking serves as a cause of the emergence of lung cancer. Because the etiological fraction can be greater than the excess fraction, the probability of such an inference can be greater than but cannot be smaller than the actual fact. This can be expressed as the following inequation (Broadbent, 2013: 162-181). Of course, because law courts must reflect specific individuals' characteristics such as family histories and occupations, the inequation does not represent the minimum threshold level for the admissibility of evidence of epidemiological evidence. Through such an inference, if and when a particular hypothesis has been fulfilled, it is possible to derive probable conclusions for individual cases based on epidemiological evidence (Broadbent, 2011). This is no different from methods that are customarily used in criminal courts to derive probable conclusions regarding the possibility of the defendants' commitment of crimes. Regrettably, however, legal circles still remain inadequate in their understanding of associations between epidemiological evidence and particular causal relationships and have charged individuals with greater responsibility for disease emergence. Law courts are

lenient toward manufacturers of tobacco, whose toxicity is equivalent to that of drugs, but are very parsimonious about protecting citizens who have developed lung cancer after consuming tobacco, such a dangerous product. How, then, should law courts' judgments on causal relationships and selective adoption of evidence be understood?

The South Korean Supreme Court's recent sentence is regrettable in that it went against the tendency in the jurisdictions of North America including Canada increasingly to charge tobacco companies with greater responsibility. This is because the verdict, instead of earnestly deliberating on the issue of acknowledging causal relationships in individual-level cases through epidemiological evidence, actually reduced the obligations of tobacco companies instead, with the Product Liability Act as a shield. Moreover, in considering lung cancer as a specific disease based on a misunderstanding of the mechanisms of disease emergence, the sentence failed to face directly the problem of damages due to chronic diseases, which have increased in high-level risk society. If the logic of the recent Supreme Court sentence is expanded, it will become impossible for citizens to be adequately protected against diverse health-related risk factors that can be caused by private enterprises. For example, all lawsuits filed by individuals regarding diseases due to fine dust, fast food, genetically modified organisms (GMOs), and excess food additives and castor sugar which are called "negative external effects" in economics such as respiratory ailments, obesity, adult diseases, and diabetes will inevitably be dismissed for the reason that they cannot prove causal relationships. Such sentences are a far cry from scientifically conventional wisdom. The South Korean judiciary therefore must review epidemiological evidence more closely and objectively in individual-level cases claiming compensation for damages and must study legal principles that are capable of determining the probability of the existence of causal relationships. Otherwise, judgments on legal causal relationships will inevitably become even further removed from the reality, and the relief of victims and the benefits and protections of laws will exist in name only.

In conclusions, epidemiological research results are imbued with social authority as are physicians' written appraisals, and statistics figures are seen as objective and highly reliable. However, even with epidemiological research results, the possibility of errors exists, and subjective interpretations can intervene in the selection of the groups studied, evaluation of the data collected, and interpretation of the results (Dreyer, 1994; Shafer, 1986). Consequently, epidemiologists at times disagree on the association between exposure to a particular risk factor and the development of a particular disease as well. At such times, the association is gradually determined through more follow-up studies. However, adequate consideration of the possibility of errors is necessary when epidemiological research results are used in lawsuit procedures as a ground for the argument for the existence of a causal relationship between the plaintiff's disease and a particular factor. In addition, there also are cases where epidemiological results only point at the statistical association between exposure to a particular

risk factor and the risk of developing a particular disease without being able to determine the existence of true causality. Nevertheless, epidemiological research results are necessary for proving individual causal relationships, all the more so from the perspective of lawyering. Epidemiology helps to establish rational and consistent standards regarding causal relationships by combining statistics with biological or medical knowledge and determining the causes of diseases that develop in humans. Consequently, epidemiology can have a certain role in proving legal causation if and when courts establish a set of standards concerning the problem of inferring legal causation from epidemiological causal relationships. Of course, epidemiology is still a discipline unfamiliar to most jurists, and courts have not yet engaged adequately in discussions on the appropriate role of epidemiology. Nevertheless, frequent are cases where, in lawsuits for damages due to harmful substances, there is no way to prove causal relationships except with epidemiological research results. Fact-finding is not dependent solely on probability. It comes about through experienced judges' intuition after a consideration of all other aspects including the nature of the issue at hand, the purpose of the system, and the nature of the judicial proceedings. Consequently, it is invalid to approach the legal principle of fact-finding probabilistically for establishing legal causation. It is necessary to understand epidemiological research results accurately in terms of their advantages and disadvantages and to evaluate their value as evidence wisely. The magnitude of causal contribution of a specific risk factor with respect to disease occurrence is expressed in the form of the population attributable fraction. The present study examined ways of applying the population attributable fraction in data to individual levels. The population attributable fraction can be used to presume the probability of causation because there exists a certain relationship between the attributable fraction and the probability of causation. Consequently, when determining the causality of disease occurrence for individuals in court, it is necessary to acknowledge the admissibility of evidence held by the attributable fraction figures presented by epidemiologists. This is the way to meet public sentiments and to render society at large, which is healthier through the regulation of harmful substances.

Acknowledgements

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