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REVIEW ARTICLE

Wake-Up Call for Action: The Current Situation of Public, Global and One Health Education during Medical School in Times of Globalization and Increasing Health Threats: A review

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ABSTRACT

Public, Global, and One Health are individual approaches to health that partly influence each other and all are becoming increasingly important in medical education. ''Public Health'' is an approach to protect and improve health of a population. Nevertheless, most health threats are transcended national boarders, so the "Global Health" approach is becoming increasingly relevant. The holistic approach "One Health" goes even further: in addition to human health, animal health and the environment must also be considered. All these approaches are influenced by globalization, the increasing immigration and the occurrence of pandemics. Accordingly, it is the responsibility of higher education institutes to integrate health approaches in their curriculum to train future physicians to meet the demands of their patients and the population.

This review reflects the current situation of the mentioned approaches in medical education in different countries from which data are available. The research shows that there exists a wide range of Public Health programms, but they are rarely assessed and only a small number of degrees programes is offered for physicians. In contrast to this, Global Health activities during medical education are more reported, and the main providers for Global Health education are medical schools. The necessity to implement One Health topics in medical curriculum is seen by many organizations, but there are just a few publications about the implementation in medical education available.

The main issue in educating health approaches is a missing standard; the dissent of competences, which are relevant to future practical use; the curriculums are oversaturated; and a lack of expertise to the topics. For the future there is a need to implement health approaches into the core curriculum of medical education. Therefore, it is a possibility to integrate the subjects into existing activities and to use didactic concepts, such as clinical rotation, problem-based learning, or case-based learning. In addition, interprofessional work and partnerships between medical and Public Health communities must be improved.

Public, Global, and One Health education requires a structured and comprehensive curriculum that ensures adequate training of medical students in an increasingly globalized world and diversified patient population.

Keywords: public health, global health, one health, medical education

Introduction

Since ancient times, the health of its population is prerequisite for the survival of human societies. Therefore, health regulations have been devised to promote health in order to counteract the effects of epidemic infectious diseases [1]. Today, Acheson defined Public Health (PH) as "the art and science of preventing disease, prolonging life and promoting health through the organized efforts of society" [2]. It is generally perceived as the approach to protect and improve the health of people and their communities through promoting healthy lifestyles, researching disease and injury prevention, and detecting, preventing and responding to infectious diseases. Therefore, it is crucial to promote health care equity, quality and accessibility [3]. The three major demands of PH are: application-oriented, population-based, and interdisciplinary [4]. In current times globalization, climate change, social inequity, demographic development, and changes in the spectrum of relevant diseases are building the framework for the PH approach [4].Regarding medical education PH topics include quantitative sciences such as biostatistics and epidemiology; social, behavioral, and environmental sciences; the study of health systems (health policy, financing, and regulation); clinical and community preventive services; and leadership and communication skills [5].

However, PH is not to be confused with International or Global Health (GH). While PH focuses on health within a local and regional population, international health operates bilateral (e.g. development cooperation in a developing country), and GH as an expanded concept extends the same principles transnational to people worldwide considering that health issues transcend national borders [6]. Progressing globalization with modern transportation, greater reliance of exports and a global business market together with of increased immigration and the occurrence of pandemics demonstrate the increasing need for a GH approach [7,8]. PH can be seen not only as one aspect of GH but as an essential element [9]. Nevertheless, because globalization plays such a crucial role these days and conditions that foster disease onset are often the same worldwide [10], GH approaches cannot be neglected even when focusing on the health within only one population. The GH strategy of the federal government of Germany (2021) goes even further and explains that our well-being also depends on the environment, climate change, animal health and PH [11]. This holistic approach is called "One Health". By understanding the interactions of human and animal health, and ecosystem, GH risks can be identified and addressed. This interdisciplinary approach emphasizes that human and animal health depends on global communities taking responsibility for protecting the environment [11]. Global initiatives become of ever-increasing importance to PH. However, the national PH institute of Germany, the Robert-Koch-Institut (RKI), criticizes that the concept of PH is poorly established in German PH institutions. This also includes the current state of PH, GH and OH education [12]. Especially, higher education institutions are responsible for integrating basic principles of GH to their PH education curriculum [10]. Therefore, this summary reflects PH, GH and OH education during medical studies in different countries from which data are available.

Public and Global Health in Medical Curricula

Health can be influenced by different factors. For example on one hand, there still exists a tight link between social background, education and health today, and significant regional differences in life expectancy occur [13]. On the other hand, pandemic infectious diseases like the current COVID-19 pandemic are threats to populations´ health. Medical schools are responsible for providing physicians who are familiar with the community and its health problems, their prevention and solutions [14,15]. To meet these demands, there has been a growing call for expanding PH content in medical curricula. With better PH knowledge health workers are better in anticipating and contributing to interventions during a pandemic [5].

In most European countries, PH education has traditionally been integrated into the medical curriculum, to offer a continuum between clinical and population medicine. Additionally, there are PH schools that belong to national health authorities or the local government [16]. When looking for papers reflecting on the situation of PH education, mostly information on specific PH degrees or electives can be found. This is in accordance with the observation by Maeshiro and Carney that the term 'PH' is not consistently used in medical curricular standards [5]. There exists quite a wide range of PH undergraduate and graduate programs as well as postgraduate programs for physicians. Those aim at training PH experts but the situation of PH education in European medical schools to build a common basic knowledge for all physicians is rarely assessed. For the U.S. a study by Resnick et al. assessed the situation of PH education up until 2016, not focused on medical schools. They found that most PH education historically had occurred at the graduate level but that more undergraduate programs had emerged in the past decade. Almost 80,000 undergraduate PH degrees from 271

institutions were conferred during 2003-2016, with more than half between 2011 and 2016. They reviewed 296 institutions and found that 95% offered a Bachelor of Science degree, such as the Bachelor of Science in PH or Bachelor of Health Science. The main providers for PH education were found to be colleges or schools of health professions or health science and in colleges of arts and sciences. Only a small number of PH degree programs were offered by other types of colleges, including medicine [17].

Once PH education is offered, there are two foundational competencies PH students should be able to demonstrate: the ability to communicate PH information, in both oral and written form, through a variety of media and to diverse audiences, and the ability to locate, use, evaluate, and synthesize PH information [17]. Talking to medical students one topic they found to be missing was nutrition. Nutrition and diet plays a pivotal role in PH. As key contributors to the growing trend of obesity in children and a lifelong disease burden associated with the metabolic effects [18,19]. It has been pointed out that physicians should already early in their training be educated on the importance of nutrition in normal growth and health, PH aspects of nutrition and the relationship between nutrition and disease [20].

More information can be found on the integration of GH topics. A study by Kaffes et al. identified 33 GH educational activities at 18 German universities in 2016. Some examples mentioned were a six semester-long elective course from the medical school of Hamburg, a final year elective "Tropical Medicine and Global Health" at the University of Würzburg and two mandatory GH courses, one being a lecture on PH at the University of Bonn, the other a seminar series on GH ethics at the University of Erlangen-Nuremberg. Nevertheless, the situation of GH opportunities in Germany were perceived as insufficient in quality and quantity by a majority of educators and students. The study did not focus primarily on medical education but found that medical schools were the main provider for GH education. They had to point out that only 34% of German medical schools offered any GH education. More than two-thirds of students and educators suggested that GH education should be part of the core curriculum in medical education [21]. Especially because a relevant proportion of the student population aimed to work internationally, but are unprepared. Other ongoing problems surrounding GH education in Germany are: GH is often merged with PH; the focus of GH education is often on cultural competencies, while health system approaches were neglected; lack of differentiation between "internationalization" of education and GH education; low priority given to GH by faculty members and academic management levels; a lack of institutional structures; lack of an interdisciplinary approach and a shortage of educators [22,21]. Similar results are shown by a study from the UK. The authors surmised that the differences between the curricula amongst the medical schools show a lack of coherence and standard in GH education in the UK [23]. Also in Sweden is no uniform approach of GH education reported [24]. Regarding GH education in U.S. a great majority of medical schools offered a student-led interest group at the minimum. Some were offering GH as an option for first-year areas of special interest that could be chosen from and noted GH being highly popular [25]. Overall, as of 2010 almost one-third of medical students graduating in the U.S. and Canada participated in a GH experience [26].

Overall, the development of a structured and comprehensive curriculum that covers all relevant learning objectives of GH education is needed to ensure adequate training of students in an increasingly globalized world and diversified patient populations [23]. GH education therefore could greatly improve students' competencies associated with cross-cultural or international work and help them develop skills for future work as clinicians, which are essential aspects of health care [24].

Perspective of Public Health collaborations

As discussed at the *Future Forum Public Health* (Association of actors from the PH sector in Germany) in 2016 in Berlin, one of the main focus points should be to permanently cross-link different institutions relevant to a PH approach [27]. Over and over again the need for interdisciplinary and interprofessional work both in terms of research and education is mentioned as crucial to a successful PH strategy for Germany [13,28]. Especially the integration of the PH system into research, education and practice is highlighted [28]. Partnerships between medical and PH communities would improve the prevention and management of chronic diseases, injuries, and substance abuse; strategies to catalyze improvements in social determinants of health and achieve health equity; and the formulation of health-focused approaches to address global challenges like climate change [5]. Further, "collaborations have the potential to recruit a more diverse student body to study PH, which, in turn, could diversify the ranks of future PH professionals" [17]. Seen as a reason for the lack in collaborations between clinical and PH professions

are differences in perspective and priorities. From the side of medical schools to overcome this gap, medical curricula should at least include explanations of PH systems, the responsibilities of physicians to their local and state governmental PH agencies, and opportunities for collaboration. All physicians should at a minimum have knowledge about policies that will affect the health of their patients, communities, and practices. On top of that, physicians should be trained to advocate for PH policies, programs, infrastructure and funding in order to improve and protect the health of their patients and communities [5]. Another recommendation to expand access to PH education is a collaboration between undergraduate institutions and community colleges. Thereby, community colleges educate in foundational or core courses (e.g. "Personal Health: A Population Perspective", "Overview of Public Health", "Health Communications") to prepare students for a range of health professional degree programs, and recruit more diverse PH professionals [17].

Didactic concepts for educating Public and Global Health

A major problem is the fact that there exists little agreement on what constitutes appropriate PH training for medical students. Even a literature review has found no clear consensus on which GH competencies are relevant and important for future practical use [7]. Furthermore, proven methods and approaches of teaching GH competencies, beyond didactics and experiential learning, have yet to be established. The most commonly cited GH competencies were understanding of the global burden of disease, travel medicine, healthcare disparities between countries, immigrant health, primary care within diverse cultural settings, and skills to better interface with different populations, cultures, and healthcare systems. However, no single one was mentioned more often than 16% across the reviewed articles, showing a lack of consensus [7]. This might also be due to the fact, that competencies were not addressed in all articles and even though there is a growth of GH programs, few sought to demonstrate what competencies were acquired. Finding a consensus on the relevant competencies would help ensure that all medical students were exposed to similar basic levels of training [7].

As mentioned above there are several degrees and courses that educate on PH topics, but mostly either as separate degrees or without specifically using the term 'PH'. This was noted as a "thicket of qualifications offered and intransparent career paths" which complicates orientation for all parties involved. Germany is said to be missing a common strategy in educating and encouraging PH personal, although adequately trained personal is the basis for reaching all PH goals. Therefore, experts are calling for an overlapping strategic plan between different institutions and agreement on the core medical curriculum. In addition, a common core curriculum would improve quality and comparability [28].

However, the importance of ongoing healthcare professionals being trained in aspects of PH and GH is undeniable, as it entails dealing with an increasingly diverse (patient) population, questions of ethics and human rights concerning medical care, understanding the health care system oneself works in and other people live with and more [29,23,30]. When exposing medical students to GH issues they were largely encouraged to enter primary care medicine, obtain PH degrees and engage in community service [31,32], as well as practice medicine among the underserved and multicultural populations [33,34,31,32,35]. Especially international clinical rotations are often seen as an essential part of GH education. Medical students who had completed such a rotation often report a greater ability to recognize disease presentations, more comprehensive physical exam skills with less reliance on expensive imaging, and to approach patients with greater cultural sensitivity [25]. The typical and perhaps optimal amount of time for a clinical rotation was thought to be six to eight weeks. It had been observed that many medical students were extending their medical program duration in order to be able to pursue international clinical rotations and research opportunities. Already in 2007, several residency programs had long offered international electives [34,31,36], but earlier experiences with GH could have an even greater impact on shaping career decisions in medicine [25]. However, due to limited time during the semester and limited financial resources it can be challenging for students to obtain experience in intercultural communication or international health [37]. Here educational institutions should not only be able to provide adequate administrative support, opportunities, and time to conduct an international elective, but also assist students in accessing available scholarships that can cover travel costs [25]. In addition, the process of recognizing credits obtained at institutions abroad must be simplified.

If intercultural exchange is not possible, videoconferencing might be another option for getting students in touch with populations from other cultures and learn more about various health issues of that country on a rather low-cost [8] compared to international clinical rotations. Moreover, strong networks and methods like e-learning can help with

the ability to offer public and GH content despite limited teaching capacities [38,39].

While the need to prepare medical students for the ongoing challenges related to health and health care in a globalized world is apparent, it has remained a challenge to incorporate GH into existing curricula. Packed curricula, rigid teaching techniques, and unwelcoming attitudes towards GH have been cited as hurdles to overcome [40]. Easy ways to start the process therefore would be to develop optional elements or capitalize upon existing activities [26]. Though, this poses the risk of not reaching a broader student population and only reaching those that were interested in global health[40]. A majority of courses related to public and GH relied on lectures, with far fewer using approaches like small group teaching, problem-based learning, case-based learning, and self-directed learning [23,41]. Problem-based learning is recommended to incorporate common and important health problems, for which early diagnosis or prevention is possible, and might also help counteract the problem of missing expertise among educators as the students will be encouraged to look up information on their own [41]. As time constraints are an issue in medical curricula, the case-based approach could introduce students to GH or build on their existing knowledge of the field and engage them with the topics creatively and interactively [42].

One Health in Medical Curricula

The Paris Climate Agreement of 2015, recognized the negative impacts of climate change on populations´ health. Actions to mitigate climate change are linked to improve PH and GH. This transdisciplinary approach is called "Planetary Health" approach. Planetary health can be expanded with the focus on the interaction between humans and animals, this is referred to the "One Health" approach. This interdisciplinary and cross-sectoral approach recognizes that the health of humans, animals, plants and their shared environment are closely connected [11]. Areas of interest may be food safety, the control of zoonotic diseases, laboratory services, neglected tropical diseases, environmental health and antimicrobial resistance. New infectious diseases are often transmitted between different species. For instance, more than two-thirds of known human infectious diseases have animal origins [43]. Von Hirschhausen sees the climate crisis, species extinction and wildlife trade as main impactors for pandemics such as the COVID-19 pandemic and even names the climate crisis the biggest health threat of the 21st century. He also points out that it is much more effective and cost efficient to prevent diseases instead of treating them [44]. Because of the bandwidth of areas important to the OH approach a major focus lies on interdisciplinary training to ensure that multiple sectors can communicate and work together.

Different organizations are therefore working on formulating and implementing an OH approach. Some examples are the *One Health Commission* and the *One Health Global Network*, which represent and promote the approach. Furthermore, the international *One Health Coalition* is organizing the cooperation between OH platforms, governments and non-governmental organizations and the *International Federation for Tropical Medicine* is hosting the journal '*One Health*'. The so-called Tripartite organizations the *Food and Agriculture Organization of the United Nations*, the *World Organization for Animal Health*, and the *WHO* are committed to strengthening multi-sectoral coordination across Europe and Central Asia. In 2019 they launched a guide for countries on taking a OH approach to addressing zoonotic diseases [45]. In Germany the *German Antibiotics Resistance Strategy* is working since 2015 on preventing the rise and spread of antibiotic resistance [46]. Since 2021 the *Federal Ministry for Economic Cooperation and Development* supports the OH approach with up to 150 million Euros yearly to promote the interdisciplinary training of personal in the education system. This includes a cooperation with the *German Academic Exchange Service* to establish new OH partnerships between universities. For partnerships between clinics 3 million Euros are envisaged. In addition, a *One Health Research Education and Outreach Center in Africa* was established and is supported with 15 million Euros [46]. However, the new GH strategy of the German government, neglects education and human resources of health and ignored the demand made by the students' association of inclusion of GH in the medical curriculum [22]. This highlights the importance politics plays in education and that there needs to be more support from the government as a whole. Students' demands and wishes should be taken more into serious consideration, as they can be leaders in the development and implementation of GH education.

Recent pandemics, such as the COVID-19 pandemic, have taught us the importance of education and training in an OH approach in improving prevention, preparations for, and responses to disease outbreaks. Training and education are especially needed for medical professionals early in their careers [47]. In accordance with that the United States' *Centers for Disease Control and Prevention* has named OH an essential

focus area for higher education [48]. Togami et al. found that OH training improves preparation for disease outbreaks, it helps facilitating cooperation which in turn improve problem solving, and it helps overcoming logistical barriers more easily [49]. Several voluntary peer-to-peer reviews *Joint External Evaluations* conducted under the *International Health Regulations* by countries seeking to evaluate their capacities to address infectious disease threats have suggested a greater emphasis on the OH approach [49]. These evaluations identified the inconsistent coordination across various health sectors at the federal, state, and local levels as a major gap [50]. Applying consistent OH core competencies in education would be an important step [49]. One core competency in OH is communication, but communication remains absent in many existing programs (56%). This identification is based on the fact that collaboration and coordination across disciplines is essential to the OH approach, which demands training in communication [49]. On the aspect of the importance collaboration almost all papers agree. Linder et al. see it as essential to solving complex societal problems including climate change, toxic waste, water pollution, food safety, and food security. They suggest adding case-based OH exercises as described in Wilkes et al. to give real life examples of OH problems that the students may face in the future, or field trips as an interesting application of content to help reinforce the concepts taught in class [48,51]. In a study conducted by the *International Student One Health Alliance* Problem Based Learning sessions and group discussions were seen as the most eye-opening elements by the students. Through those sessions the students noticed that each of them had their own pieces to contribute toward solving health problems, and only through fusing them could optimal health outcomes be achieved [52].

In the U.S. at least 45 OH academic degree programs were established as of 2018. The majority of OH academic degrees were new (established in or after 2002). Among those 45 programs, 27 were master's level (60%), 10 were bachelor's (majors and minors) level (22%), and 8 were doctoral programs (18%). The same study aimed at identifying which areas important to OH were under- or well represented (***Figure 1***) [49].

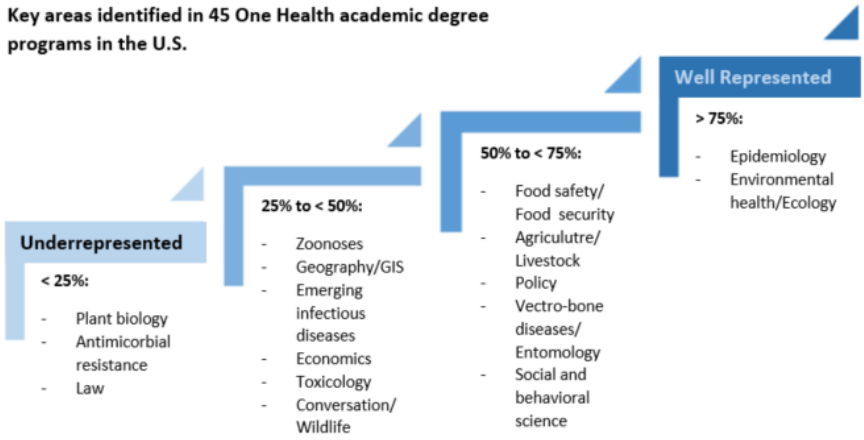

Figure 1: Key areas identified in 45 One Health academic degree programs in the U.S. [49]

None of those programs are medical programs. Von Hirschhausen recommends that it is much more effective to use already existing companies and organizations in implementing a OH approach instead of establishing new ones [44]. In terms of education this can be translated to rather incorporating an OH approach into already existing programs than establishing new academic programs focused on OH exclusively. As there exist no papers specifically about the integration of an OH approach into European medical curricula, the following sections will focus mainly on medical programs in the United States. Nevertheless, even for the U.S. there are only a handful of papers published regarding this topic.

Linder et al. acknowledged a widespread support for OH but had to emphasize that OH curricula are still in early phases of development. Similar to von Hirschhausen, they argue that established programs in OH alone do not embed widespread change within the individual health professions. Individual courses, although almost all of them being electives, are also being developed aimed at students across disciplines [48]. Some examples are a curriculum focused on food safety and security from a OH perspective from the Western Institute for Food Safety and Security [53], three Massive Open Online Courses (MOOCs) on One-Health and Global-Health by the University of Geneva and University of Basel [54] and

collaborative case-based OH exercises for medical and veterinary students at UC Davis [51]. Before taking an OH elective, only 45% of the students agreed that OH training is relevant to their future career as medical professionals. After completing the course, this increased to 75% [51].

Most papers reviewed focused on the impact of those new, single elective courses and very few papers looked at OH incorporated into established medical curricula. One of the papers that did was the study by Docherty et al., here 56% of the 133 U.S. medical schools surveyed had OH related subject matter included in their curriculum, mainly incorporated into pre-clinical training. Only 69% of the responding medical school representatives were even aware of the term 'One Health'. Those numbers pointed at medical schools lagging behind veterinary schools. If incorporated, OH was addressed within a range of subjects such as infectious diseases, zoonotic diseases, emergency preparedness, foodborne illness, patient safety and living environment assessment [47]. Many German universities list OH as a research focus on their websites, however only represented in their research not in education. It also became apparent that none of the courses taught were organized on an international level which would be vital as OH covers global topics. Reasons given for not incorporating OH into their curriculum were that the curricula of both medical and veterinary schools are already oversaturated and a lack of expertise to teach OH [47]. This goes along with the observation of a predominately "human-centric" focus and hyper-specialization throughout the medical education [55].

If wanting to incorporate OH into the medical curriculum medical schools face many challenges such as rigidness of curriculum requirements, scheduling limitations due to accreditation requirements, lack of budget, and resistance to change [56]. Ribeiro et al. pointed in their review the challenges of implementing the OH approach out. In education and training they mention the lack of competences from OH practitioner, insufficient and inefficient OH training programs, and a lack of academic and institutional support [57]. Additionally, Linder et al. point out that the field of OH is an ever-evolving area and that curricula therefore have to be modified as needed to accommodate the varying definitions of OH [48]. Through incorporation of the OH principles into already existing parts of the curriculum, many challenges can be overcome. This could start as small as discussing how OH approaches may lead to better prevention, detection, and treatment of diseases beyond zoonoses. More elaborate examples would be an integration of teaching zoonotic diseases during the infectious disease course [47] or the incorporation of animal contact histories when teaching students clinical interviewing [58]. If possible, external expertise can be brought in through clinical electives developed at zoos and other facilities near medical schools. Those have been shown to be very effective in engaging interested medical students [59]. If OH content is offered through interdepartmental and interdisciplinary collaboration it can even be done at relatively low costs [47].

Conclusion

In current times, the influences of globalization, climate change, and animal health on the health of societies are increasing. As a result, the importance of targeted education and collaborations in PH, GH, and OH is growing. Various authors are pointing out the necessity to educate medical students in health approaches, preferred in interprofessional settings, to provide knowledge that affects future patients, communities, and practices. However, one of the major problems is the little consensus about appropriate training in theses subjects for medical students. Further research and recommendations need to focus on developing unified concepts for the health approaches to implement in medical curricula which are able to adapt quickly to the ever-evolving areas.

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