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In the modern world, public libraries are looking for new ways to provide services and facilities for their patrons. As a result, some libraries are looking into opening biohacking laboratories for the public to access and use at the library's discretion. Biohacking is described as amateur, do-it-yourself scientific inquiry often intended to facilitate small improvements in health and wellbeing. As amateur science becomes widely accessible, questions are being raised about the role of libraries in providing biohacking services for the public sphere. However, ethics and responsibility are involved in opening public biohacking labs in public libraries. There are still many questions and concerns related to biohacking labs that remain to be answered. There are proponents on both sides of the debate; there are enthusiasts who embrace the potential of biohacking, and there are opponents who fear the ethical and safety implications of opening and making a lab available to scientific amateurs. Despite the promise of benefits in opening biohacking laboratories in Canadian public libraries, many risks are associated with considering the facilities. Along with the physical logistics of opening these facilities, public libraries must consider negative impacts or possible avenues of harm. Public libraries must consider the possibility of criminal conduct, the safety of patrons, and ethical concerns.

Proponents of biohacking claim it can assist with many biological issues, from weight loss to enhanced brain function. The three most popular types of biohacking are DIY biology, nutrigenomics and grinder. DIY biology is often practised by people with some experience with scientific investigation and education who help non-experts conduct structured lab experiments. Nutrigenomics investigates how food interacts with genes and is based on the idea that each person's genetic expression can be optimized by investigating which nutrients affect health over time. It has been found to decrease risks of genetically predisposed diseases, reduce depression symptoms and optimize body function like blood pressure (Nutrition Genome, 2022). Grinder is a subculture of biohacking made up of individuals who believe that the human body is hackable and can be changed through scientific intervention. They hope to optimize their bodies using chemical injections, implants, gadgets and other modifiable qualities (Washington Journal of Law, Technology and Arts, 2018). Lifestyle changes such as taking supplements and changing diet can be considered safe. However, there are examples of biohacking that have resulted in unintended consequences that can be dangerous, illegal or even fatal.

Criminality

Since biohacking is a relatively new trend practised in private and on a small scale, it has largely escaped the notice of most regulatory bodies. Traditional research is conducted by professional teams overseen by institutions obligated to conduct ethical reviews. Biohackers do not obtain ethical reviews of their work and often act independently on self-funded projects. Unlike biohackers, traditional researchers are further held accountable to private or agency funders (Zettler et al., 2019). Lack of accountability and transparency in the goals and means of the projects undertaken in biohacking labs make them susceptible to misuse by bad actors or criminals. The Federal Bureau of Investigation's (FBI) Biological Countermeasures Unit has

even undertaken a study of biohacking's potential to be used for bioterrorism (Zettler et al., 2019). Due to the decentralized nature of biohacking activities and biohacking in facilities, the FBI was forced to develop personal relationships with community labs conducting genetic experimentation (Zettler et al., 2019). The clandestine nature of biohacking activities makes them extremely hard to police and monitor, inevitably attracting criminal elements seeking to hide their behaviour.

Legislation and governance of associated risks of biohacking fall well short of what is needed. Some biohacking proponents are eager for rules and regulations. One community member said, "it is difficult to come up with/ model rules and regulations from industry and academia since they are not an exact fit (and sometimes far from a close fit). Constructing our internal policies and the documents/wording to express the lab's standards is costly both financially and regarding the number of hours involved" (Gaspar et al., p. 296). The community is trying to police itself, but effective governance and legislation must be established from a source of authority. The emerging technologies allow for a vast range of direct internal enhancement through intaking substances and manipulating the human body. The very nature of its novelty implies "inherent uncertainty regarding their personal and social consequences. Because of this, it can be argued they imply emerging risks to human health and the environment" (Gaspar et al., p. 302). The uncertainty and lack of data about biohacking are primarily responsible for the lack of regulations and guidelines surrounding the practice.

Ethical concerns

While serving the public is an admirable and worthy goal, public libraries must be aware that each person has their own individual view or perspective on acceptable standards of behaviour. Biohacking is a unique form of do-it-yourself science because practitioners primarily

experiment upon themselves. Broadly, experimenting on humans is frowned upon and considered taboo within the scientific community (Salter, 1990). Any medical procedures or interventions of a non-therapeutic nature require strict safeguards to protect subjects who may be vulnerable to negligence or maltreatment (Salter, 1990). When conducting a scientific inquiry on human subjects, adequately informed consent is considered sufficient, given

- (a) there is no other reliable or relevant route to the same end;
- (b) the end in some sense justifies the risk;
- (c) the subjects are not treated merely as means, that is, as things (Salter, 1990, p.173)

The current laws are typically outdated and make few references to the practice of do-it-yourself science (Kolodziejczyk, 2017). The moral and legal duty that currently exists is that researchers obtain informed consent from each subject before undergoing procedures that will affect the subjects' health. This duty arises from a moral concept called the principle of respect for autonomy or respect for persons. The principle defines each person as worthy of respect and having intrinsic value (Salter, 1990). It may be difficult to meet the high standards established for health procedures in a conventional setting.

Legal documents and worldwide conventions exist to help govern experimentation or scientific investigation performed on humans. There exists "legally binding documents such as Nuremberg code, Declaration of Helsinki and Belmont report [which] help govern inevitable research involving humans by requiring informed consent and IRB/REC approval" (Castelyn, 2020, p. 3). Additionally, "within structural scientific communities, researchers cannot claim that autonomy allows them to violate Helsinki standards" (Castelyn, 2020, p. 4). The Declaration of Helsinki by World Medical Associations declares that the foremost objective of health research is to produce new knowledge as long as the pursuit of said knowledge does not take priority over

the rights and interests of the research subject. Each human research study should be justified and rooted in a research protocol (Castelyn, 2020). It remains unclear if the practice of biohacking can meet this high standard, and the legitimacy and safety of the practice are called into account as a result.

Most biohacking enthusiasts have little to no formal training in conducting experiments safely and ethically. As a result, the associated safety risks are worried about by professional scientists, governments, and international institutions (Kolodziejczyk, 2017). Unfortunately, "biohackers usually do not have formally approved protocols and this lack of clarity is further highlighted when biohackers exercise their right to autonomy and self-informed consent by "enrolling" themselves as research participants in their own experiments, bypassing the role of IRBs" (Castelyn, 2020, p. 3). The purpose of IRBs, or International Review Boards, is to ensure scientific quality and integrity through mandatory risk assessments and oversights within a systematic approach (Castelyn, 2020). It has been argued that biohackers are not violating any principles because they are autonomous and self-informed. They are exercising their rights by choosing to become research participants. However, it may become possible for biohackers to stray into avenues of science, such as germ-line editing, which may hold risks and consequences for humanity (Castelyn, 2020). Unfortunately, research ethics and ethics boards have not taken the ethical conduct of biohackers seriously and have not yet addressed their conduct (Castelyn, 2020). Public libraries must consider the legal implications of allowing patrons to conduct self-experimentation on the premise.

Patron Safety

Many of the technologies that are emerging are designed to augment a biological function. Augmentation can be accomplished by implanting internal devices, intaking

substances, external devices, or gene therapy to activate genes or target defective ones. For the majority of modern medical history, these types of medical interventions were performed in conventional settings like research institutes and hospitals where procedures were controlled and regulated (Gaspar et al., 2019). While the goal of self-enhancement through biohacking may have many positive aspects, there are also emerging risks to the environment and human health. Implanting foreign objects into the human body has exposed patients to inflammatory immune reactions or chronic infections. To address the risks, an assessment must be undertaken by experts and regulators (Gaspar et al., 2019). Libraries must protect their patrons and cannot expose them to possible health risks, even if they are self-inflicted.

One risk assessment that has already been undertaken to investigate public biohacking practices was done by the European Centre for Disease Prevention and Control (ECDC, 2007). They studied DIY Biology kits which used the CRISPR technique. They reported a low risk of the release and spread of antimicrobial-resistant organisms into the environment. Using the kit also had a low risk of contamination or injury. However, since the practice of biohacking is so new, it is still considered "a risk resulting from a newly identified hazard to which a significant exposure may occur, or from an unexpected new or increased significant exposure and/or susceptibility to a known hazard" by the European Food Safety Authority (EFSA) (Gaspar et al., 2019, p. 296). As a result of the lack of regulation, novelty, and lack of quality control, there is an inherent uncertainty associated with the possible consequences to individuals as well as the environment (Gaspar et al., 2019, p. 296). Potential risks might grow in the future as access to biohacking grows, and new techniques are developed.

When groups of biohackers undertake the experimentation, it is much more akin to decentralized clinical trials. Possible applications of self-directed science could include injecting

homemade genetic material to grow larger muscles or treat diseases like herpes or HIV.

Biohacking enthusiasts have been attempting to use gene therapy to cure genetic conditions that hurt the quality of life (Gaspar et al., 2019). There is also a risk that "some biohackers might also attempt to experiment on others. Although there are no documented instances of this to date, biohackers have reported (and expressed concerns about) being approached by individuals asking for help treating their own or their family members' health conditions" (Zettler et al., 2019, p. 34). Thus, the public health risks are poor safety, lack of informed consent, lack of efficacy, and uptake of unproven therapies. There are even companies that cater to biohackers and are willing to offer any number of scientific materials for sale for the right price. Additionally, some biohackers may trade with other enthusiasts or support the work of others out of personal interest, which provides knowledge and materials (Zettler et al., 2019). Biohacking can put the entire community at risk, as well as individual patrons.

The possible impacts on patron health are wide-ranging. Some emerging fields, such as neuro-hacking, are too new to be considered safe. Additionally, the self-manufacture of pharmaceutical drugs raises public health concerns (Zettler et al., 2019, p. 34). Possible risks include seriously ill people forgoing conventional treatment in favour of self-administered interventions and possibly harmful or extreme germ-line mutations. The hype around certain chemicals or emerging treatments might also mislead the public into trying unproven therapies. (Zettler et al., 2019). Additional risks to public health include allergic reactions and contamination of the library environment from poorly kept reagents. Specific risks will depend on the context of each facility (Zettler et al., 2019, p. 34). Public libraries must protect their patrons and provide services for them. The possible health risks and negative aspects of biohacking laboratories might be beyond the scope of public libraries in Canada.

Conclusions

In modern times the growth of do-it-yourself science has been accompanied by discussion of the safety considerations involved with biohacking. While it shows promise as a means of making scientific inquiry accessible, there is a lack of data about possible consequences or outcomes. Thus, biohacking is both positive and negative in that it makes scientific inquiry available to everyone, but it introduces safety and ethical concerns. It can be difficult to determine the long-term consequences of these types of scientific inquiry, and the role of public libraries in providing biohacking spaces should be investigated. Public libraries interested in opening one of these facilities must consider some of the problems associated with biohacking, including the lack of safety control, regulation, and quality assurance. Scholars and politicians are recommending steps that can be taken to introduce regulations and oversight. The ethical implications of conducting a scientific inquiry on humans are also a concern. Overall, public libraries should be aware of the possible negative implications involving criminality, ethical misconduct, and health concerns. More research and trials are needed before the safety and viability of offering public biohacking spaces can be fully evaluated.

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