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***TATTOOS AND PIERCINGS AND HEALTH CONSEQUENCES
FOR ADOLESCENTS AND YOUNG ADULTS***

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Artigo de Revisão Narrativa

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RESUMO

As modificações corporais, entre as quais incluímos tatuagens e piercings, estão a tornar-se uma prática generalizada, e dentro da população adolescente e jovem adulta, dos 18 aos 25 anos, têm aumentado em prevalência e popularidade. No entanto, esta tendência crescente não está isenta de riscos ou de implicações a nível da saúde, estando de facto a revelar-se uma questão clinicamente relevante.

Este artigo de revisão fornece uma visão geral das atuais vertentes da arte corporal, incluindo os seus aspetos epidemiológicos, os seus componentes e limitações regulamentares associadas, bem como possíveis complicações e contra-indicações. Fornece-se informação adicional relativa ao impacto psicossocial para uma melhor compreensão do tópico, tanto para os clínicos como para a população em geral. Embora complicações graves sejam raras, a maioria das reações são imprevisíveis e incluem reações imunológicas e infeções cutâneas. A adoção de melhores condições de saúde e de um controlo mais rigoroso da saúde pública tem tido consequências positivas nos índices de complicações. No entanto apesar de todas as legislações e guias de boas práticas, estas ainda não são amplamente praticadas.

Com o objetivo de avaliar a pertinência desta intervenção foi feita uma revisão narrativa da literatura. Recorrendo a vários motores de busca científica extraíram-se artigos científicos originais, revisões narrativas e sistemáticas e meta-análises, publicados a partir de 2010 (à exceção de dois artigos publicados previamente, com a devida justificação na secção Materiais e Métodos). Adicionalmente, foi feita uma pesquisa das várias referências bibliográficas dos trabalhos que foram selecionados na primeira fase de pesquisa, respeitando as condições anteriormente impostas.

Este artigo visa rever as modificações corporais, centrando-se nas suas complicações e procurando desenvolver abordagens práticas que assegurem os melhores cuidados de saúde para todos os jovens afetados. Ter consciência das muitas vertentes da arte corporal permite uma prestação de cuidados de saúde mais segura e holística. Assegura-se também uma melhor relação médico-doente entre os clínicos e os indivíduos que tentam ajudar.

Palavras-chave: Arte corporal; modificação corporal; tatuagens; piercings; epidemiologia; efeitos adversos; infeções; diretrizes

Tattoos and piercings and health consequences for adolescents

ABSTRACT

Body modifications, in which tattoos and piercings are included, are becoming a mainstream practice and within the adolescents and young adults, 18-to-25 years old population, both have increased in prevalence and popularity. However, this growing trend is not free of health risks and implications and is starting to become a clinically relevant issue.

This review provides an overview of the current aspects of body art including its epidemiology, its components and associated regulatory constraints as well as possible complications and contra-indications. Additional information on psychosocial significance is provided for a better understanding of the topic for both clinicians and to the general population. Although severe adverse effects are rare, most reactions are unpredictable and include immune-mediated reactions and skin infections. Acknowledging better healthcare standards and more stringent public health mandate has had positive consequences on complications rates, however despite all regulatory measures, they are not of yet widely practiced.

In order to assess the relevance of this paper, references were found as costume for narrative reviews of literature. Through a search of several databases, papers of various typologies were selected: original articles, systematic literature reviews and meta-analysis. All concerned at least one of the debated topics and were published since 2010 (except for two articles issued before, justified in the Materials and Methods section). Additionally, the various bibliographical references of the works that were selected in the first phase of research were also reviewed, respecting the limits previously imposed.

This paper aims to review body modifications, focusing on its complications and looking to develop practical approaches to ensure the best medical care of all youngsters affected. Being aware of the many dimensions of body art facilitates safe and holistic health care provision, improving the therapeutic relationship established between clinicians and the individuals they serve.

Keywords: Body art; body modification; tattooing; body piercing; epidemiology; adverse effects; infections; guidelines

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ABBREVIATIONS AND ACRONYMS

BP: Body piercings

NTM: non-tuberculous micobacteria

PMU: permanent make up

USA: United States of America

NSSI: non-suicidal self-injury

FDA: Food and Drug Administration

CoE ResAP: Council of Europe Resolutions

TiO₂: titanium dioxide

PPD: paraphenylenediamine

DOT: Deutsch Organisiert Tatöwier

UETA: United European Tattoo Artists

CO₂: carbon dioxide

ISS: Itch Severity Scale

DLQI: Dermatology Life Quality Index

MRSA: *Methicillin-resistant Staphylococcus aureus*

RGM: rapidly growing mycobacteria

SGM: slowly growing mycobacteria

HPV: human papilloma virus

UV: ultraviolet

HBV: hepatitis B

HCV: hepatitis C

HIV: human immunodeficiency virus

AIDS: Acquired Immunodeficiency Syndrome

PAHs: polycyclic aromatic hydrocarbons

DIC: disseminated intravascular coagulation

AAP: American Association of Pediatrics

1. INTRODUCTION

Body art is modifying the body, making it our own canvas, and it has been in practice for centuries, in many civilisations, with different meanings and motivations (1-12). What were once pain relief strategies are now fashion statements and ways of self-expression (2-4, 6, 8, 10, 13-18). Body art includes tattoos and body piercings (BP), and, whilst much of the existing literature on tattooing explores piercing and tattooing together, these body modification choices differ in motivations and health consequences (19). Tattoos, or decorative permanent tattooing, involves the introduction of exogenous pigments and/or colorants into the dermis to produce a permanent design (11). Piercings, on the other hand, are adornments made by literally piercing the skin in a semi-permanent way, usually with a metallic piece in areas such as earlobes, nose and navels.

Epidemiology is interesting, whether studies have been performed in the USA, in Europe or in Australia, the overall prevalence of tattooing is around 10–20% (16) and increasing, the same applying for BP. For this paper this was relevant as the main group of interest are adolescents and young adults (11-29 years old). In fact, recent studies recognised body modifications as becoming a mainstream practice, one specifically stating that in the general population, within the young adult, 18-to-25 population, currently one in four have tattoos and one in three have body piercings, with less (one in 34) having intimate piercings (18). According to the Pew Research Center, tattooing definitely belongs to Generation X and is a part of the Millennial Generation, mainly those born at the beginning of the 1980s; 38% of millennials have at least one tattoo and 23% have a piercing somewhere other than an earlobe (20). However, this growing trend is not without health risks and implications and is starting to become a clinically relevant issue. In accordance with Serup et al (21), health issues were divided in complaints and complications – complaints being mild alterations, acquired along with and caused by a tattoo/piercing, to which people don't usually seek medical attention; and complications being more serious adverse reactions, considered as diseases and to which individuals request professional medical advice and treatment. Be that as it may, and even with complications being common, current literature has concluded that most costumers of tattoo/piercing parlours, mostly teenagers and young adults, display a major lack of knowledge on the possible consequences that their choices can have, and decide to mark their bodies in a (semi)permanent way without fully comprehending the possible implications (5, 22-25).

This paper aimed to review existing literature on the topics of body art evolution with its complications, focusing on dermatological infections. Indeed, a considerable number of reports

describing cases of atypical microorganisms' infections have been published with special emphasis on non-tuberculous mycobacteria (NTM) as contaminating cosmetic procedures. Risk factors and health implications will be discussed, as well as possible psychopathological constraints.

The aim is to develop guidelines and practical approaches to ensure the best medical care of all youngsters affected, preventing this issue from becoming a public health issue. With this in mind, the topic of deferring blood donations after a previous percutaneous needle treatment such as tattooing and piercing is also debated so to understand if the risk of blood-borne infections still justifies this measure.

2. MATERIALS AND METHODS

Research methods were as costume for narrative reviews. Studies focusing on body art, either tattoos or piercings, their epidemiology and associated constraints were analysed, as well as those referring to possible complaints and complications. All work related with dermatological consequences and infections deriving from these procedures were also under the scope of assessment. Papers of various typologies were selected: clinical cross-sectional case-control studies, cohort studies, systematic literature reviews and meta-analysis, comprehensive reviews, case reports, time series analysis and original articles. All concerning at least one of the debated topics.

Research work was done during the period May to September 2020 using the following search engines: PubMed®, ClinicalKey™, Google Scholar™, Medscape® and AccessMedicine®. It was made considering a population of only adolescents and young adults, 11 to 29 years-old, by the use of the MeSH terms: “Body Piercing, Tattooing, Epidemiology, Skin Diseases, Infectious”. The purpose of the search was to find related issues associated with body art and the paediatrics population, in which the following search terms were used, either in the title, abstract, keywords or content: (*"Tattooing/adverse effects"[Mesh] AND "epidemiology" [Subheading]*), (*"Body Piercing/adverse effects"[Mesh] AND "epidemiology" [Subheading]*), (*"Skin Diseases, Infectious"[Mesh] AND "Tattooing"[Mesh]*), (*"Skin Diseases, Infectious"[Mesh] AND " Body Piercing"[Mesh]*).

Only articles that dated a maximum of 10 years back (2010) and published in English, Portuguese or Spanish were selected for references.

During the selection of the articles, duplicated articles were excluded, as well as guidelines from scientific societies which considered individuals older than 29 years old.

In addition, a review of the various bibliographical references of the works that were selected in the first phase of research was conducted, respecting the limits previously imposed.

In the specific case of original articles, two exceptions were made for undeniable significance although dating from before 2010 – a report from 2007, by Norman Goldstein, which was determinant to define the issue of tattooing and a case study from 2005 which related one specific fatal outcome from tattooing.

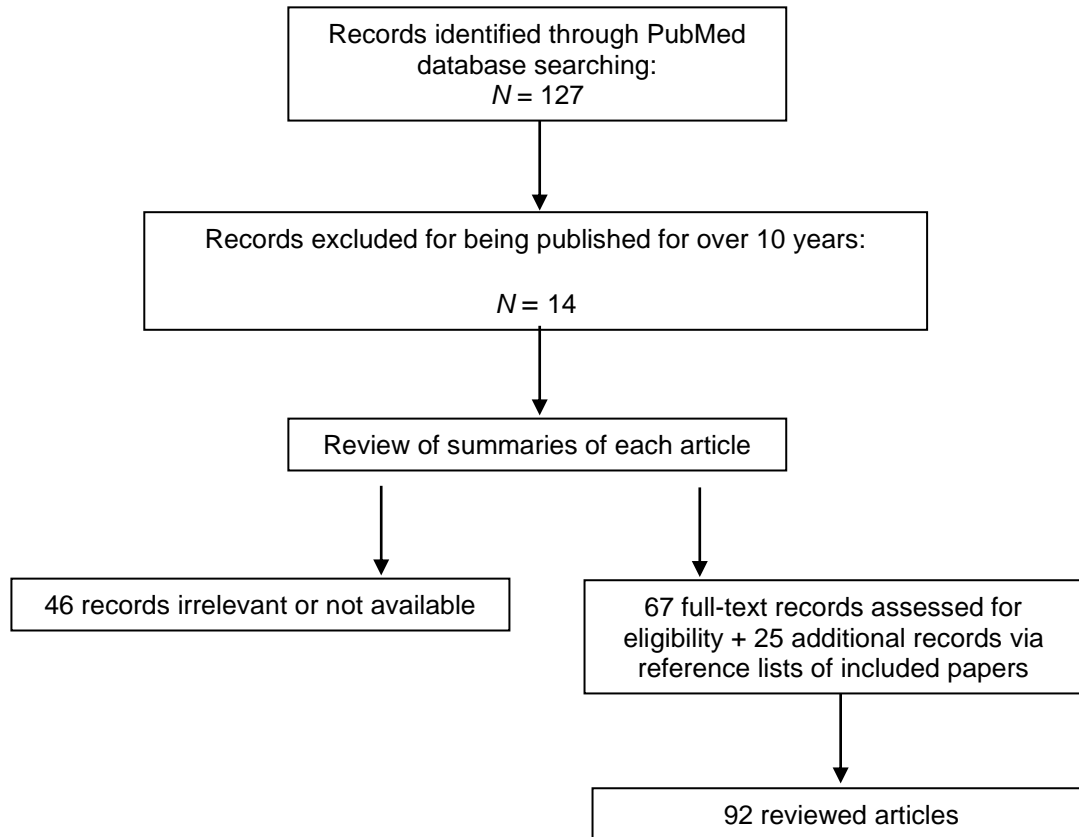


Diagram 1. Illustrating the method of research and selection of the revised articles.

3. RESULTS

3.1. Types and Methods of Body Modifications

Body modifications, on which we include tattoos and piercings, are a growing trend among adolescents and young adults, one that doesn't show signs of decreasing in the near future (26). Although they are both forms of body art, they differ in motivations, methods and health consequences (2).

3.1.1. Tattoos

Tattoos, deriving from the Tahitian "ta-tau", "the result of tapping", is defined by the Chambers Dictionary of Etymology as "a verb to "mark the skin with pigments" (11, 17, 27, 28). Tattooing consists of permanent imprints of ink, which are exogenous pigments or dyes, placed within the subcutaneous layer of the skin through needles (29); these can be divided into decorative, traumatic or medical categories (see Table 1). Whilst accidental tattoos can happen after injuries, like blasts or road traumas, in medicine, tattoos can be used as a dermatological camouflaging technique in the presence of vitiligo, scars, hair loss or the reconstruction of breast areola after breast cancer surgery. Another type gaining societal acceptance, is tattoos as permanent makeup (PMU). These are performed by beauticians and advertised to be waterproof, time saving, and hassle free. However, the main group of tattoos continue to be decorative tattoos, which are the most common and are primarily used for aesthetical reasons, current fashion or personal meanings (2, 4, 5, 17, 28).

The history behind tattoos goes back to 3000BC, with their original use in the Neolithic period. In subsequent years, it was a prohibited practice and remained a secret activity until the eighteen century when James Cook, the English explorer, described the Polynesian technique of "tattaw" in his diaries. On his return, James Cook was credited with introducing the world of tattoos to Europe. Tattoos then became a symbol of wealth among upper social classes and nowadays has been recognised as a legitimate form of art, accepted by both genres and age groups as a highly fashionable mode of self-expression (2, 4).

The procedure itself, as performed today, can be seen in several videos on YouTube and other video repositories in which viewers can learn about safe and acceptable methods of tattooing, which can be divided in four moments (6):

- 1) Selecting or designing the art to be drawn in the skin with the appropriate antiseptic cleanser;
- 2) The procedure itself, in which professional tattoo artists use a motorized, electric-powered machine that holds needles which can puncture the skin up to several thousand times per minute;
- 3) Post procedure when an additional antiseptic is applied and the tattoo is covered;
- 4) Finally, aftercare consists of exposing the tattoo to open air and applying antibiotic ointments to the tattooed skin, thick skin cream, or vitamin E oil several times daily. This process can take up to 2 weeks until the tattoo is fully healed.

3.1.2. Body piercing

Body piercing has been defined as the “penetration of jewellery into openings made in such body areas as eyebrows, lips, tongues, nose, nipples or genitals” (7) and arises from the verb “to pierce”, which means to transfix, being a deliberate and somewhat semi-permanent procedure, considered a factor that may cause alteration of local homeostasis and exposure to communicable diseases (10). Parallel to tattoos, the popularity of BPs is increasing, especially among adolescents and young adults. This is associated to the cultural commercialism spread by the media, hence it now being seen across different age and social groups (8).

Similar to tattoos, body piercings have been practiced in almost every society throughout history. Evidences of body piercing has been found in preserved bodies from up to 5000 years ago (8). In ancient civilisations this accessory entailed military, religious and socio-cultural issues, having sparked prejudice due to the association with rebellious behaviours (10).

3.2. Epidemiology

The different results vary according to the population of interest, the country of origin and the time when they were conducted, but in 2015, Kluger et al (16) established that the prevalence of tattooing was about 10-20% worldwide, whether studies were performed in the USA, in Europe or in Australia. However, he also reported that the data on prevalence and incidence in other populations outside Western countries was sparse (1). Nevertheless, for the past years, tattooing and body piercing have become further debated and publications

have multiplied, suggesting a change in motivations and perceptions of tattooed individuals by both society and themselves (6, 16, 17, 26, 30, 31).

Most statistical analysis concerning body modifications focus on the people in the USA, which represents a significant population as they usually mirror major trends worldwide. In fact, approximately 24% of the US population from late childhood to age 60 is reported to have at least one tattoo. Europe is also following this trend, with an estimate of more than one million Europeans displaying tattoos (4).

Generational names are still employed by popular culture in order to organize age groups. There is Generation X, which covers those born between 1965 until 1980; the Millennial Generation, referring to those born after 1980 and the firsts to come of age in the new millennium; Generation Z, for those born between 1995 and 2009 and who are the students of our world today, currently in school and university; and finally Generation Alpha, pre-schooler and kindergarteners or those born after 2010 (32).

Tattooing is shown predominantly in Generation X and the Millennials. Hence, recent studies show how younger groups followed the example considering that for the past years, body art, mainly tattooing and piercing, has gained tremendous popularity and visibility (16). In fact, the Harris Polls, performed successively in 2003, 2008, 2012 and 2016, confirmed this increase, with 22% of youth 18 to 24 years of age reported having a tattoo (33).

Previous clinical studies with samples age 12 to 22 established that 10% to 23% obtained tattoos, and body piercing (other than the earlobe) ranged from 27% to 42%, with higher rates of tattooing and body piercing among girls versus boys, and older versus younger adolescents (6). For Majori et al (26), body piercings were regarded as ubiquitous and concerned all socioeconomic and age groups, with a major concentration between 15-30 years old. In the USA, Germany and Italy, this same study reported tattooing as a very common practice, primarily in younger subjects.

Another study group which has consistently been studied to understand the epidemiology of tattoos was inmates. These groups ranked as one of the most tattooed populations even though its practice is illegal in most prisons throughout the world. In fact, it has even been estimated that 40% of inmates get tattooed in prison, with only a slight difference depending on the country (16).

Additionally, elite athletes are a rising group of interest whose body image must be carefully managed as it reflects his or her identity, and connects directly to their social,

cultural and/or ethnic backgrounds (6, 16). As Kluger et al (34-36) stated in his studies, tattoos appear frequently in team sports, especially in football and basketball. The prevalence of tattoos among the top 100 players in July 2018 was 9%, with higher numbers in women. Nevertheless, these figures remain lower compared to the general population in the same age group (20–40 years, approx. 30%).

3.3. Information about societal perceptions of body modifications, association with high risk/deviant behaviours and body dysmorphia/self-injury

Social contexts can have dramatic effects on decisions (37) and tend to dominate many aspects of the everyday life, and influencing the decision-making process even if unconsciously.

Within the topic of body modifications, gender differences are evident; men have more tattoos while women have more piercings (18). Traditionally tattooing has been more accepted and prevalent among men than females. However, women are catching up. In 1990 half of all tattoos were being performed on women from every social class. Since then tattooing has quadrupled among women in such a way that today the numbers for the two genders approach equality (16). In the USA, the prevalence of tattoos on women has surpassed that of men (30), and in Australia whilst in general men are still more likely to be tattooed than women, the figure changes when focusing on the individuals between 20-29 years of age in which they are predominant on women (29.4 vs. 22.3%) (38).

In the past, high-risk behaviours were often associated with body modifications (2, 6, 9, 10, 18, 31, 39-43), though current studies do not consistently support this. In a retrospective analysis from 2007 to 2008, tattoos were associated with alcohol, drugs, violence, weapons, sexual activity, eating disorders, and suicide (8). Similar conclusions were reached by Guéguen et al (41, 42) in 2013 when he assessed that screening for tattoos and body piercings could be used as a marker for alcohol and tobacco consumption in young French adults. However today such link to risk behaviours cannot be hastily made as evidences of this are less consistent. There are always numerous factors and biases: studies among teenagers versus a more general and adult population (usually more frequent), the inclusion of other pieces of body art (piercings, microdermals, transdermal piercings, etc.), the number of tattoos, their sizes, their locations and even tattoo designs (16) which can alter results. Despite these limitations, it has been accepted that public opinion of the link between having a tattoo and deviant behaviour is changing. Indeed, the motivations driving individuals to get body art can range from therapeutic purposes, to group affiliation signs, to self-expression or to simply fashion accessories. The need to embellish one's body and the

search for individuality appear to be the main driving forces (16). This is true for both tattoos and body piercings.

An assessment of those with piercings found the age for the first adornment was 14 ± 3 years of age (10), this being younger than tattoos' and with a higher prevalence. Owen et al (18) reduced them to less relevancy by claiming them as nothing more than fashion accessories, hence a person needing at least nine lifetime piercings to see a demarcation into high-risk behaviours. When analysing intimate piercings (nipple, genital or both) only one was necessary to reveal this tendency. As it happens, Owen's study allowed to understand when body modifications should be perceived as deviant attitudes. He determined that individuals with four or more tattoos, seven or more piercings, and/or intimate piercings were the ones with significant mental, emotional, or physical issues or were victims of sexual abuse. Therefore, this group had higher probability of engaging in risky behaviours or even portrait certain personality traits and self-reported psychopathological symptoms. However, literature is scarce when evaluating the relationship between body modifications and eating disorders, with mixed results. The findings have also been less consistent with regard to the association between BP and depressive symptoms (31).

On the other hand, body modification should not be confused with non-suicidal self-injury (NSSI) (6, 43). The American Psychiatric Association has guidelines to distinguish typical body modification from this more dramatic, intense effort to harm oneself. This syndrome, described in the 'Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition' (44) includes cutting, scratching or burning oneself; an impulsive or compulsive action that is associated with mental health disorders (psychotic, personality and anxiety disorders) (43). Intention is the most important indicator to differentiate NSSI and body modification.

Despite increased societal acceptance of tattoos and piercings, there may still be repercussions when seeking employment or educational opportunities. Adolescents and young adults contemplating body modifications should be advised to ensure any tattoos or piercings are not visible in typical work attire (6).

3.4. Tattoo components

Tattoos are typically a large dermal wound embedded with particles of pigment and liquid ink (2). It is commonly assumed that there are government regulations for tattoo inks like other skin products, like cosmetics. Unfortunately, this is not completely true (45). Tattoo inks are complex mixtures consisting of pigments suspended in one or more diluents, with

added ingredients such as binders, surfactants, preservatives and fragrances that alter viscosity and other properties to aid the tattooist's craft (2, 6, 15, 21, 45).

Although in the USA tattoo inks are considered by the Food and Drug administration (FDA) as cosmetics and the pigments as additives, the FDA neither approves nor regulates these products as they do medications or medical devices. Similarly, in Europe there is no enforcement of regulations (4). Hence, tattoo inks may contain harmful components (2, 6, 15, 21, 25, 45, 46). As manufacturers or suppliers have no obligation to disclose the components of their products, some pigments used in inks are not always produced with the purpose of being placed in the human dermis for extended periods of time. This means that no risk assessment is performed before commercialization and that there is no public organism to ensure quality control (15). Bearing this in mind and considering potential regulations, the Council on Europe Committee on Cosmetic Products convened the Council of Europe (CoE) Resolutions (ResAP), in 2003 and then again in 2008, to provide guidelines regarding the safety of tattoo pigments (4). It aims to limit the concentration of impurities in products to be used in tattoos. In here certain substances that get into direct contact with the skin are completely banned from consumer products under different legislative frameworks (47) due to their carcinogenic, mutagenic, or other adverse properties (15). Nevertheless, analytical studies of ink composition show that these propositions are not always acquiesced (15) and other past case reports still identify contamination by metal particles (15, 46). A swiss study of 73 brands of tattoo ink found that 14% of the samples contained preservatives banned from cosmetic use (48).

Though the concentration of metals in inks is low, they are emerging as a major concern due to the possibility of being human carcinogens (6). In 2011, a study in the British Journal of Dermatology reported the discovery of nanoparticles found in tattoo inks (25). Due to their microscopic size and increased surface-to-volume ratio they are able to enter and travel through the blood stream (21, 25, 46) coming into close contact with the immune system (45). This consequently leads to a potentially higher release of toxic elements when present (46).

Over the past years, black tattoo ink was formulated through a mixture of iron salts and carbon with the addition of dyes in order to diminish the use of heavy metals and achieve better colours. These colorants are mainly organic, with azo or polycyclic pigments but nonetheless, antimony, cadmium, lead, chromium, cobalt, nickel, and arsenic may still be present as contaminants (2, 4, 15, 25). Several studies using detailed analysis' mechanisms reported the presence of multiple elements at levels exceeding the traditionally accepted limit of 1 µg/g (4, 15, 46).

Exploring the tattoo process, a study from 2019 reported that nano and micrometre sized particles were also abraded from tattoo needles when using TiO₂-containing ink (inorganic white titanium dioxide) but not with carbon black. These particles also contained nickel and chromium that were permanently deposited into the tattooed skin and translocated to lymph nodes (46). As such, this study provided the first proof that not only tattoo pigments but also abraded iron, chromium, nickel and steel particles are distributed towards the lymph nodes.

Another aspect of tattoos causing increased concerns within health departments are the potential infections from the inks itself (2, 49). Tattoo parlours can claim to be hygienic and clean albeit not sterile. As such, the possibility of bacterial contamination is being negligible. Ten percent of new inks are contaminated with bacteria pathogenic to humans, independent of any claim of 'sterility' (49).

3.5. Henna tattoos

In recent years, henna application, in the so-called temporary henna tattoos, has become a growing fashion trend, especially among children, adolescents and young adults in western countries (50) and those holidaying in exotic places (51). Its increased popularity can be linked to its painless, decorative and not permanent characteristics with a maximum lifetime of three weeks (52).

Henna is made up of dried and powdered leaf of the dwarf evergreen shrub *Lawsonia inermis*, a member of the family *Lythraceae* (50-53). It has been used for over 4000 years as an expression of body art, especially in Islamic and Hindu cultures in the Arab, African and Indian world at festive events such as weddings and religious ceremonies (6, 50, 51).

For centuries it has been mixed with other ingredients such as essential oils, dried plant leaves and varied other powders until it achieves a paste-like consistency of reddish-brown colour, which is then used to stain the skin, hair or nails (6, 50). This is known as the 'red henna' and is the most typical henna used. However, recently it has become common practice to add paraphenylenediamine (PPD) to the traditional henna mix. This is a synthetic dye that accelerates the drying process of henna tattoos on the skin, as well as induces a darker, more brilliant hue, creating the so-called 'dark henna' (51). De Groot et al (50) in his study reported that 24 out of 25 commercial samples of henna tattoo had PPD as an ingredient.

In opposition to permanent tattoos, black henna tattoos offer a self-limited alternative and its procedure involves no needles. The dye is applied by brushed or special pens on the skin. Therefore, there is no risk of introducing infective agents (50). Nonetheless, it is not an innocuous procedure.

In fact, the PPD added is an aromatic amine (52) and a powerful contact allergen that can induce sensitization after only one exposure (51). Though PPD has been used in hair dyes for more than 100 years, and it can be found in nearly 70% of all hair products today (52). PPD is also a component in leather, fur, textiles, nylon stockings, rubber, paints, photographic developers, and various industrial printing inks (52) and therefore particular jobs such as hair dresser, masseur, petrol pump attendant, leather shop assistant, or workers in the cellulose and plastic industries may carry higher risk of intensive contact with PPD (50). When used for black henna, the ink is usually extemporaneously prepared by the artist with a variety of materials and sources. The actual concentrations of PPD and of the other ingredients may vary greatly. In Germany, the henna dyes contained, on average, 6% PPD and in Spain, the United Arab Emirates and the United States concentrations were >10% (50).

3.6. Piercing components

The literature on piercing and its materials is limited as most piercings consist of hoops, studs, or barbell shaped ornaments which size and shape are mostly determined by the body site pierced and by personal preferences (6).

The most commonly used material is metal, either stainless steel, gold, niobium, titanium or alloys, while silicone and plastic can also be found (7). Gold is often combined with nickel or other metals to make alloys that have improved hardness and durability (6).

3.7. Legal and regulatory issues for both tattooing and piercing

According to the place of study, jurisdictions will vary. In the USA, there are no federal laws regulating body art practices, and state laws widely vary (2). There were no uniform standards until 1990, when an interdisciplinary collaboration of academics, public health professionals, professional organizations, physicians, environmental health experts and body art practitioners gathered to create a guidebook entailing recommendations and guidelines on sanitation and infection control, and was later updated in 2019 (54). Even with these regulations, 72% of states do not effectively regulate sanitation, training, licensing or infection control (6).

European regulation is different, as state members of the EU abide by the Council of Europe (CoE) Resolutions (ResAP). The main purpose of the CoE ResAP is to harmonise legislation in the public health field and to insure customer's safety in relation to tattoos and PMU products' (47). In this document there is a list of good practices to which governments of member states must abide by. It requests the withdrawal of certain chemicals along with the correct labelling and packaging of instruments to ensure their sterility and correct disinfection. Additionally, they requested that tattooists share all the reliable and comprehensible information about the risks entailed by tattooing, including the potential occurrence of sensitisation with their costumers (47).

The Portuguese government has not yet adopted these regulatory standards in opposition to the Netherlands, for example. They have not only implemented these measures but are in the forefront of up and coming regulations and controls of tattooing, known as the Amsterdam model (49). The same can be said of Germany, whose Association of Professional Tattoo Artists (Deutsch Organisiert Tatöwier, DOT) in association with the United European Tattoo Artists (UETA) developed hygiene guidelines to be applied in tattoo studios (55). A Portuguese review from 2018 (56) tried to bring attention to the lack of jurisdiction in its own tattoo policies. It reported that even before the CoE ResAp was released, a manual of good practice had already been delivered to the State Secretary for Trade, Services and Consumer Protection with no improvement in implementing good quality control measures.

What is also of relevance is the age by which adolescents can get pierced or tattooed. In the USA, where every state is responsible for its own regulation, at least 45 do not allow minors to get tattoos unless they have parental permission. In specific cases, the consenting adult must be present at the time of the procedure and he/she must sign an informed consent (6). Those who disrespect these norms are punished with fines and/or prison time. The problem then lies with the teenagers who fabricate their age or go outside of established parlours being exposed to increased health risks (2). A study from 2018 reported that individuals aged 15 years of age were 79x times (95% CI 16.9–367.6) more likely to provide a false age compared with individuals aged 18 years and over (14). This is also seen in other countries, like Brazil. One specific study showed that 41.85% of recruiters had tattoos aged 16 years or younger, and 30.99% got them without consent (57).

3.8. Acute and chronic potential medical complications

3.8.1. Tattoos

There is an increasing amount of reports from physicians and in medical literature about tattoo complications (47, 58). A study from Kluger et al. (1) used Google Trends as a tool to analyse seasonal and long-term assessments of trends of public interest and it corroborated this assumption. It reported an increased search for tattoos' complications, manifesting with itching, bumps, and induration on tattoos.

In Italy, Galle et al (59) found that among 597 tattooed adolescents, 23.4% reported complications more frequently if their tattoos were obtained in unauthorized facilities compared to those who obtained their tattoos in professional, regulated studios (35.3% vs. 15.9%, respectively). In India it has been documented that tattoos are more commonly done at the roadside and in makeshift salons. In these the sterility of the instruments is questionable, thus increasing the risk of adverse reactions (17).

Available data has generally been collected from self-reports of tattooed individuals on questionnaires. For example, a German survey from 2010 registered that 67.5% of the questioned individuals complained of health problems after tattooing. Of the respondents, 10% had "moderate" complications and 1.8% had "intense" to "very intense". However, only 1% of the individuals consulted a physician (60). At this point it is not known whether complications are becoming more frequent and, if so, how quickly (61).

Comparing the large number of tattoos placed everyday with the reports from clients, the rate is likely low. Indeed, most medical literature emphasises only on local clusters of infections or on threats to public health (6). The high variability of results is due to methodological bias but also to the tendency of studies to overestimate the acute 'complications' after tattooing by confounding 'complications' with the symptoms that almost always occur during the healing process. Itching, tenderness, pain, or fluid discharge may be the most common complaints (45, 62) but they are also part of the tattoo healing phase (60).

The process of tattooing itself creates a dermal wound that is complex and continuous throughout the lifetime of the tattoo (2). On an initial phase, the skin is not only reacting to the ink but also to the trauma of hundreds of needle piercings, to the alcohol used on the skin surface and carried in by the needles, and to the diluent used as a carrier for the ink (4, 25). The physiologic response may cause blood clots to form around broken blood vessels, creating a bruise and swelling as a way of protecting the area from further injuries, and helping it to heal (25). This is called an acute aseptic inflammation (47, 58).

In accordance with Serup et al (21), health issues can be divided in complaints and complications. Complaints are known as mild alterations, acquired along with and caused by a tattoo, to which people don't usually seek medical attention; Complications tend to be more

serious reactions, considered as diseases and to which individuals request professional medical advice and treatment.

For the diagnosis of health adverse effects, clinical pattern recognition is essential, along with a complete patient medical history including any clinical signs and symptoms. Histology presents itself as an extra tool for supplementary information in case of doubt or when grading severity prior to treatment (21).

Although there are many reports subdividing the adverse effects of tattooing (2, 4, 21, 23, 45, 60), the Joint Research Centre from the European Commission (47, 58) has analysed complications and organised them under the following categories:

- Acute aseptic inflammation;
- Allergic/hypersensitivity and auto-immune type reactions:
 - Allergic reactions (delayed type iv allergies);
 - Underlying dermatosis reactivated by tattooing (the Köebner phenomenon);
 - Other secondary effects;
- Infectious risks (bacterial and viral);
- Other secondary effects:
 - Pigmentary disorders;
 - Tumours;
 - Medical diagnostic and treatment interference;
 - Contraindication to tattoo procedure.

All reports accept that adverse tattoo reactions may start either early, right after the tattoo procedure, or occur later on, potentially months and years afterwards. This paper focuses on infectious complications while reviewing some of the most common reactions.

Acute aseptic inflammation

Acute aseptic inflammation is the immediate and transient reaction of the skin to the punctures of the needle and takes place already while the tattoo is being placed or removed, immediately followed by a wound healing process (2, 23, 47, 58, 60). It can have different degrees of manifestations but most common are erythema, induration and an oedematous '*peau d'orange*' around the tattooed skin; they are also generally warm and sensitive to touch healing within 2 to 3 weeks with superficial crusts (23, 60).

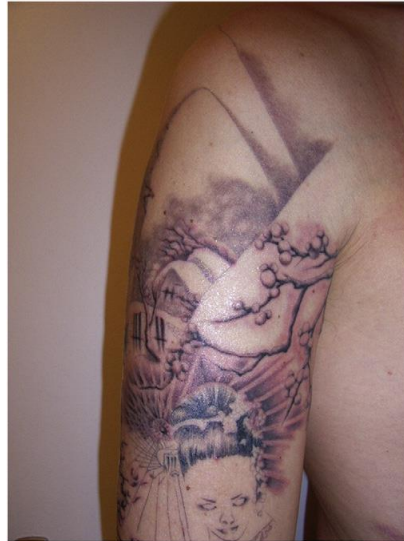


Figure 1. Inflammation around the tattooed area a few hours after the session (63)

Allergic/hypersensitivity and auto-immune type reactions

- Allergic reactions (delayed type IV allergies)

Delayed type IV allergies, also called allergic contact dermatitis, are the second most reported side effects caused by tattoos reported in the literature (45) and considering the prevalence of tattooed individuals – ranging from 8.5 to 24% of the population across Europe and the USA (16), accounting for a large number of affected people.

According to Serup et al (21, 64) tattoo allergies are characterized by non-infectious, chronic reactions with persistent symptoms exceeding 3 months. Usually itching, swelling and dermal inflammation, which appear confined to one specific colour inside the tattoo (monomorphic). This diagnosis is valid even in the absence of a valid test reference. Indeed, epicutaneous tests (like the patch test) measure immediate IgE-mediated-responses, therefore they are often negative in these delayed reactions (2, 21, 23). Standard test methods used for cutaneous allergy are consequently not useful in the diagnostic evaluation of suspected allergies (21)

Reactions to tattoos vary from immediate to delayed, local to systemic and may present as multiple different morphological patterns (4) including eczematous and lymphohistiocytic, granulomatous, lichenoid or sarcoidosis-like reactions and pseudolymphoma (6, 21, 23, 45). These terms, however, are not specific and may overlap in the same biopsy thus not being used to label tattoo reactions (23). Nevertheless, any granulomatous reaction should prompt to look for underlying idiopathic sarcoidosis as a sarcoidal reaction may be a nonspecific finding or a manifestation of systemic sarcoidosis

(17). Similarly, a lichenoid reaction can be associated with genuine cutaneous or mucous *lichen planus* (23).

This inflammation is caused by sensitivity to tattoo pigments (6) or even needle wear (46). It leads to focal oedema, pruritus, papules, or nodules at the site which may disappear spontaneously or after decades (58).

A survey from 2013 (45) confirmed these reports and evidenced that skin reactions were more frequent to coloured tattoos (83.3%) than to black tattoos (12.5%) (45). In fact, red and purple/violet are the most. The red pigment is the most problematic (4, 17) and even with modern adjustments replacing cinnabar (mercury sulphide) with azo dyes, the problem was not eliminated (2).

Hypersensitivity reactions can resolve spontaneously or become chronic. Literature states that tattooed individuals only seek medical attention when the reaction is disabling or severe. Treatment is often difficult and can depend of potent topical corticosteroid ointments, tacrolimus or intralesional corticosteroids. If there is no improvement, then removal by surgical excision, dermatoma shaving or destruction by CO₂ or Q-switched Nd:YAG laser can be suggested (23).

It must be noted that chronic tattoo reactions can be a cumbersome dermatological disease and must be given priority attention as they qualify for treatment by the public health care system (62). One of the most prevalent complaints is itching. Previous studies have concluded that in the Itch Severity Scale (ISS) and in the Dermatology Life Quality Index (DLQI), this symptom was comparable to others on widespread dermatological diseases such as psoriasis (23, 62).

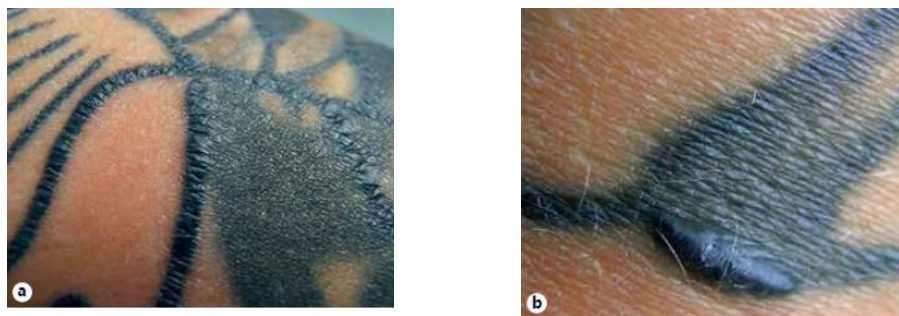


Figure 2. Papulo-nodular pattern a) Elevated black lines with irregular and confluent thickening, in contrast to a normal black tattoo without any change b) Nodular elevation spontaneously ready to release excess pigment (65)



Figure 3. Plaque-like pattern a) Flat elevation of the entire tattoo where lilac ink was instilled. b) Flat elevation of a red tattoo c) Flat elevation and major thickening limited to a red tattoo and sharply demarcated towards normal skin (65)

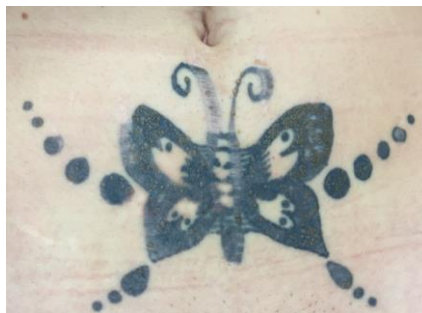


Figure 4. Multiple flat-topped papules distributed in pigmented areas of the infraumbilical tattoo (65)



Figure 5. Detailed view of the cutaneous lesions presented in the tattoo (65)



Figure 6. Reaction towards the pink color (66)



Figure 7. Reaction on the red of a tattoo (67)



Figure 8. Complications from cosmetic tattoo of the eyebrows (68)

- Underlying dermatosis reactivated by tattooing (the Köebner phenomenon)

Included in the scope of hypersensitivity is the Köebner phenomenon. This happens when pre-existing conditions such as psoriasis, systemic lupus, sarcoidosis (6) or *lichen planus* and vitiligo (69) reappear in response to a traumatic insult to the skin, such as tattooing. Reinhart et al (69) reported the case of a 21-year-old Naval active duty male presenting a reactivation in a rare form of psoriasis. Erythematous nodules with pronounced ostraceous scale overlaid a right upper arm tattoo.



Figure 9. Ostraceous, scaling plaques outlining markings within the patient's recent right upper arm tattoo (70)

Allergic reactions to temporary henna tattoos

Red henna is relatively safe. It has minor sensitizing power and there are very few reports of hypersensitivity reactions (51) despite its extensive use (6, 50, 51). However, the henna compound has only been tested in a few studies and the actual allergens remain mostly unknown (50).

When considering black henna, also called a “temporary tattoo”, the addition of PPD changes the clinical prospect. PPD is a powerful contact allergen that can induce sensitization even after a single exposure and has been considered as the main factor for the onset of contact allergies (51).

This PPD is present not only in the henna ink but also in hair dyes and varied cosmetics. Allergic contact dermatitis may therefore develop in patients with or without previous sensitization to PPD. It can occur after acquiring a henna tattoo or have no clinical manifestation until another contact with the PPD from a different source (51). In the United States, the Food and Drug Administration found PPD in 4 of 10 henna samples (hair dye, powders, paste, kit, ink, and tattoo), with concentrations ranging from 4.28% to 27.24% (50).

Clinical manifestations are the ones in typical acute allergic dermatitis with erythema, oedema, papules, and vesicles (50). They usually follow the outline of the original tattoo and appear strictly localized to the area (51). However, there have been reports of angioedema, neutrophilic dermatitis (Sweet Syndrome), eosinophilic dermatitis (Wells Syndrome) and even systemic manifestations like anaphylactic shock, renal failure and seizures (52).

As such, contrary to popular belief, henna tattoos should not be regarded as innocuous and risk-free (51). They can have permanent consequences such as post-inflammatory hypopigmentation (very frequent especially in children). PPD-sensitized people may experience problems working as printers, hairdressers or in occupations in the leather, rubber and textile manufacturing industries (50).



Figure 10. Erythematous papules, vesicles and blisters in the henna tattoo area (71)

Infectious risks

Tattooing, by using needles to penetrate the skin barrier and introduce pigments, opens the door to infection (2). A local infection is most likely to be the first suspected complication, irrespective of the symptoms and delay of onset (61). Tattoos entail physical injury and depending on the hygiene conditions during the process, it may promote the transdermal transmission of viral and bacterial infections (45). Primarily due to self-medication in mild infections, in which no clinical treatment is sought, the overall incidence of infection is unknown. The same with the rate of systemic complications (i.e., bacterial endocarditis) or the cost of treating such complications. Nonetheless, the frequency of infections is believed to be very low (4).

Although complications may occur in professional parlours, they develop mainly in amateur/homemade tattoos or if performed by unlicensed tattooist (so-called 'scratchers' or 'backyard tattooists') (60). Current literature states that it is the insufficient or complete lack of sterilization that causes most cases of infection (2). Thus hygiene measures, modern aseptic tattooing techniques and better education of the tattooists will likely assist in decreasing those infectious complications (23).

There are 3 potential origins of infection: tattoo ink itself can be contaminated, especially by bacterial pathogens; inadequate disinfection of the skin area to be tattooed, allowing for residential bacteria to enter the skin during the tattooing process; during the healing process after tattooing, when patients feel pruritus, the risk of superinfecting the tattooed skin area due to scratching may lead to the inoculation of microorganisms (45).

In spite of recent guidelines, it was found that as many as 10% of new inks, labelled as 'sterile', were contaminated with bacteria that are pathogenic to humans, thus the labelling being unreliable (21).

- Bacterial infections

Bacterial skin infections are seen in 1-5% of individuals following a tattoo (4, 17), typically within 4-22 days after receiving the tattoo (2). They may occur during the healing phase and be restricted to a single colour. It requires a differential diagnosis with allergic reactions (23).

Manifestations vary widely (4) and may present as abscesses, impetigo, cellulitis, plaques, ulcerative nodules, monomorphic papulo-pustules, fasciitis, or gangrene (2). Clinically they can be organized in superficial, deep or severe pyogenic infections, and atypical mycobacterial infections (6, 23). In spite of some infections being rare, endemic, or historical they still represent a potential treat (21); inoculation leprosy is still endemic in India for example (48).

In today's clinic, the main risks associated with tattoo procedures are pyogenic infections with *Staphylococci*, *Streptococci*, *Pseudomonas*, and *E. coli* (21) but *Methicillin-resistant Staphylococcus Aureus* (MRSA) infections are becoming more common in tattoos applied by unlicensed tattooists. Of note, an outbreak of 44 cases lead to an increase in MRSA infections in Kentucky, Ohio, and Vermont (4). The current spectrum of *Staphylococcus aureus* infection includes most local superficial pyogenic infections such as folliculitis, impetigo, furunculosis and ecthyma.



Figure 11. Infectious complications of tattooing. a) Staphylococcal infection seemingly introduced with yellow tattoo ink b) Pyogenic infection in an entire tattoo c) Bacterial infection of soft tissue of the arm (72)

Concerning the more severe local infections, erysipelas and gangrene, they are usually rare but not impossible (60). In fact, in New Zealand and Australia there were reports of some cases of polybacterial cellulitis, necrotizing fasciitis, and septicaemia with potential multiorgan failure including one which resulted in a fatal outcome of a 29-year-old man (73).

Systemic infections may indeed occur. There are reports of sepsis, toxic shock syndrome, and spinal epidural abscess (4, 48). However, most cases are not due to the tattoo process itself but rather to the comorbidities the patient already presented.

Management of most infections is similar to other skin pyogenic infections (6) by implementing oral or intravenous antibiotic treatment. However, all therapeutic approaches must include tracing the route of infection to its source in order to prevent new cases (74).

It must be pointed out that non-tuberculous *mycobacteriae* (NTM) have re-emerged (47). They are divided in rapidly growing mycobacteria (RGM) and slowly growing mycobacteria (SGM), both ubiquitous in the environment, found in the water, soil and dust (75). The incidence of cutaneous infections by these microorganisms used to be associated with immunosuppressed patients (76) but since 2005 several outbreaks in professional tattoo parlours have been reported worldwide (60). This pathogen is now linked to both immunocompetent and immunocompromised individuals (75).

In 2014, a retrospective study of 5 years concerning 12 patients presenting to the Department of Dermatology, and Scottish Mycobacteria Reference Laboratory from the Royal Infirmary of Edinburgh, were diagnosed with cutaneous eruptions due to *M. chelonae*, some secondary to immunosuppression, others recently tattooed individuals. There are also several cases reported in France, in the USA and in Australia (23). Sergeant et al (77) described infections by *M. chelonae* in four immunocompetent individuals who were tattooed by the same artist in Edinburgh. This was later reviewed by Scott-lang (76) in his 5-year-study.

This phenomenon correlates with the increasingly popularity of tattoos (75). Contamination could theoretically occur at any point of the process. Conaglen, in one of his studies (75), found it to be associated with the use of unsterile tap water or with the presence of bacteria in unopened tattoo ink bottles (60). In spite of legislations implemented, no regulation is stated instructing the use of sterile water to rinsing needles for tattooing or to dilute black inks and obtain different shades of grey (76).

Skin and soft tissues infections associated with NTM most commonly include the *Mycobacterium fortuitum* group: *M. chelonae*, *M. abscessus* (including *M. massiliense*), *M. haemophilum*, *M. ulcerans* (Buruli ulcer), and *M. marinum*. Indeed, grey colour usually involves diluting black ink with distilled (but not sterile water) and *M. chelonae* is often waterborne. Corroborating this is the report of an outbreak of *M. chelonae* infections affecting 19 individuals tattooed by the same artist in Rochester, New York. The source was found to be the premixed tattoo ink contaminated before distribution (78).

The typical pattern of inflammation observed is a granulomatous reaction (4). It can be a mild inflammation with local rash, papules, or nodules, or present severe abscesses and requiring extensive and multiple surgical debridements (6). This infection develops slowly (74) with an incubation period of 3 days to 1 month (60).

Diagnosis of this situation should be suspected if there are similar symptoms in costumers from the same tattoo parlour during the same period (60). Skin biopsies and bacterial cultures of skin and inks are necessary to confirm this possibility and initiate treatment (23). Molecular techniques could also be employed for diagnosis, but are less sensitive than culture (76). Cases can be self-limited with no treatment (79) but management strategies usually involve antibiotic sensitivities and consultation with infectious diseases' experts to design a treatment plan (6). Most patients are likely to require a prolonged course of antibiotic therapy, usually for a minimum of 3 months. Whilst clarithromycin monotherapy may often suffice (76) some patients may require combinations of antibiotics to ensure effective treatment with a tetracycline or a fluoroquinolone (79).

It is worth noticing that the use of topical antibiotics for mild infections following a tattoo increases the theoretical risk of germs developing resistance against some antibiotics (58).



Figure 12. Lesions caused by tattoo-associated skin infection with rapidly growing mycobacteria. A) Healing lesions localised in the grey-shaded areas of the confirmed case's tattoo. The skin biopsy site is also visible B) Erythematous papular eruptions within the tattoo of one of the probable cases (80)



Figure 13. Erythematous hyperkeratotic papules restricted to the grey areas of the tattoos with presence of scattered pustules (81)

- Viral infections

Several reports registered cases of viral human papilloma virus (HPV) and *molluscum contagiosum* lesions developing in tattoos. They are usually seen as common, plantar and juvenile warts (45), after an incubation period of 1 month up to 10 years (23).

Wenzel et al (45) reported a case of a man who presented with multiple warts restricted to the tattoo area after sunburn damage. The patient had the tattoo for 2.5 years and this study concluded the HPV had been latent until it was reactivated by the local UV-induced immunosuppression. Such a long latency led to the hypothesis of these viral infections being part of the Köebner phenomenon on pre-existing skin lesions (47).

Although the mechanism for contracting these lesions remains uncertain (23) it has been widely accepted that transmission happens during the tattooing process or due to the presence of HPV in the tattoo dyes (58). As such, these situations are primarily associated with unsanitary facilities (47). Viral sobre-infection may also happen. There has been a reported case of cutaneous lesions developing 3 days after tattooing attributed to *Herpes puncturum* but further study concluded there was a previous infection by *S. aureus*. Treatment demanded the use of antibiotic and antiviral therapies as well as pain management strategies (6).

On the other hand, as tattoo instruments are in close contact with blood and bodily fluids, if tools are not sterilized or if there is no proper hygiene procedures it can result in the blood-borne transmission of hepatitis B or C among tattooed costumers (60). There is strong evidences for the transmission of hepatitis B and C from tattooing (45). The current focus on health care and safety control has allowed for the implementation of guidelines for tattooing, which has had a positive impact in the epidemiological status. Urbanus et al (82) in 2011, and later Tohme et al (83) in 2012, ascertained that “in low HBV/HCV-endemic countries where strict hygiene guidelines for tattoo and piercing practices have been implemented, like in the Netherlands, tattoo and piercing practices are not associated with HBV/HCV infection”.

Some studies even say that the HCV risk factor from tattooing is epidemiologically irrelevant (58). Still the threat of hepatitis B and C remains when considering home (or prison-) made tattoos or when performed in unregulated settings (58, 60).

Still under the spectrum of viral infections is the possibility of HIV transmission. Though this risk is thus far theoretical as HIV virus needs a massive and prolonged body fluid contact, which is unlikely to happen during a standard tattooing session (47). In his review, Kluger et al (60) only found one possible case of AIDS contamination happening in 1988, and involving two men who received tattoos in prisons.

- Tumours

There have been reports of neoplasms associated with tattoo placement but it is unknown whether this is a coincidence or a causal effect (6). Despite tattoos being practiced for centuries, the chance of cancer arising in a tattoo or in other organs due to its pigments has not yet been recognised as a significant clinical problem (74). A nation-wide survey in Germany reported only 0.1% cases of skin cancer in tattooed skin, all in males and with most tattoos being coloured and not black (45). Kluger et al (84) extensively reviewed literature and found only 50 cases of cutaneous tumours on tattoos, melanoma being the most frequent. Comparing to the dozens of millions of tattooed individuals this number seems negligible (58).

Nevertheless, there are many substances in tattoo inks which are known carcinogens and mutagens, including polycyclic aromatic hydrocarbons (PAHs) and nitrosamines. Nanoparticles are also added to inks and by travelling through the blood stream may have the ability to act as carcinogens (2). Such concerns have yet to be proven in the medical literature and therefore remain hypothetical (74).

One accepted confounding factor is the possibility of malignant lesions appearing in the same location as a tattoo. Tattoos hinder a careful clinical and dermatoscopic control of *naevus*, averting an early diagnosis and treatment. In fact, tattooing over a benign melanocytic *naevus* might be the triggering reason for it to malignantly degenerate (23). When suspecting of a tumoral lesion, distinguishing between benign lesions such as pseudoepitheliomatous hyperplasia and keratoacanthomas, from squamous cell carcinoma, basal cell carcinoma and leiomyosarcoma can be difficult. It may imply full thickness-biopsies and/or surgical removal of entire lesion with thorough histological examination (23).



Figure 14. A patient with extensive tattoos on the whole back making it difficult to examine numerous moles (85)

3.8.2.Piercings

From a medical perspective, 70% of those with a body piercing are estimated to present undesired local and general effects. Therefore, it is not a harmless procedure (8). However, no reliable estimates are available regarding people who have experienced complications related to body piercing (6).

According to Hennequin-Hoenderdos (8), whilst most medical literature regard piercings as uneventful, the possible severity of short- and long-term complications make them a relevant public health issue. The development of lesions and adverse effects depend of several factors such as the body region pierced, the manner of insertion and maintenance conditions.

A British cohort study between individuals aged 16 to 24-year-old reported that the complication frequency linked to pierced body areas is as follows: perineum (44.6%), breast nipple (24.7%), navel (14.8%), ears (14.4%) and nose (8,9%) (86).

Management of complications may imply the removal of the causative agent. Although serious consequences are rare, they remain a possibility even years after the piercing was placed (8).

Ear, nose and navel piercings

A recent study from Perry et al (14) showed that according to the age group the proportion of skin infections varies – of those aged under 16, 28% reported skin lesions. This could be due to younger children being unable to maintain adequate after care on their piercing and therefore being more susceptible to complications. Interestingly, the attitudes

towards infections also diverge. Only 19% of those with self-reported infection admitted visiting a healthcare professional. Those under 16 years at the time of screening were even less likely to seek medical attention following a skin infection.

Studies concerning cutaneous piercings have shown that manifestations usually involve infections, cysts, oedema, granuloma, hematoma, keloids, hypertrophic scars, abscesses, contact dermatitis and allergic reactions, with most reaction-prone sites being the navel, ear and nose (10).

Skin infections can be local like impetigo and cellulitis, or more severe such as osteomyelitis, toxic shock syndrome, or bacteraemia (6). Assessment of cutaneous lesions in a sample of 58 pierced medical students reported that 50% had local reactions: 55.2% with infections, 37.9% with pain/swelling/inflammation and 24.1% with hypertrophic scar/keloids in the first six months after the insertion (10). Treatment options for keloids include surgical excision, intralesional corticosteroid injections, cryosurgery, pressure dressing, radiation, and laser therapy (6).

On the other hand, superficial earlobe infections tend to have a benign course and respond well to local treatment, including warm, moist packs and application of topical antibiotic ointment. For more severe lesions, first-generations cephalosporins (eg, cephalexin or cefadroxil and penicillinase-resistant penicillins) are more appropriate options but it also depends on the microorganism present (6).

Allergic reactions are most common with nickel, a metal and known allergen commonly present in piercings. Despite regulations, 16.2% of 160 piercing posts exceeded the 0.35 mg/cm² threshold of nickel release and further 2.0-5.9% exceeded the high limit of 0.88mg/cm² (87). Patch tests can be used to confirm this allergic sensitization to nickel (10). Resolution of allergic dermatitis involves the use of topical corticosteroids and avoiding further nickel contact (6). Choosing decorative pieces only made from surgical stainless steel, gold, titanium or acrylic is recommended plus periodically removing and cleansing them (10).

There have been reports of some life-threatening cases after body piercing including septic arthritis, endocarditis, and hepatitis B and C (6) along with a fatal case of toxic shock syndrome after home nipple piercing (14). Piercings acting as a transmission method for HIV has also been suggested but no evidence has confirmed this hypothesis (6).

Oral piercings

Despite the oral cavity being an environment conducive to bacterial proliferation, the infection rate is low (6). However, the severity of possible consequences makes it far from harmless (12).

In intra and peri-oral regions, complications include pain, oedema, airway obstruction, grooved or fractured teeth, gingival trauma, tongue and lip injuries, interference with mastication, speech, salivation, halitosis, periodontitis and foreign body aspiration (10). Chipping or fracturing of teeth is reported to be the most common dental problem (6, 12). But gingival recession is also one of the main consequences of oral piercings and of particular relevance because it facilitates the development of hypersensitiveness and root caries, besides possibly having negative aesthetic results (7).

Tongue piercings have their own specifications and can be reservoirs for periodontopathogenic bacteria (8). Ziebolz et al. (88) ascertained that insufficient oral and piercing hygiene were significant to increase its pathogenic potential.

Systemically it may also be a vector for the transmission of blood-borne virus, in the same way that tattoos are, and also for *herpes simplex* and the Epstein-Barr virus (12). Bacterial inoculation is also a possibility, primarily with *Neisseria*- and *Streptococcus viridans*-induced endocarditis and even Ludwig angina (12), a rapidly spreading oral cellulitis (6).

On the other hand, there is the chance of airway compromise due to trauma, tongue swelling and obstruction by jewellery. Not only it may be impossible to secure an adequate airway or intubation due to complex piercings, but they can also be aspirated or swallowed thus leading to respiratory difficulties (6).

Intimate piercings

Research on this topic is limited, with little information regarding college students with nipple, genital or both piercings (89). However, this is a growing trend and several studies from the last years (2004-2010) reported an increase on its practice (18) and its complications. Individuals often seek nonmedical advice from the Internet or go to their piercers for fear of ridicule, or for not trusting on medical knowledge and assuming they would have to remove the piercing (90).

Intimate sites include single or multiple piercings of the nipples, clitoral hood, inner and/or outer labia, perineum, penis, foreskin, and scrotum, all vulnerable to complications (89).

Abscess formation has been reported after nipple piercing (6). A report from 2010 tried to bring attention to a case of a 23-year-old woman who, 5 months after having her nipple pierced, developed a breast abscess. Nipple piercings have a longer healing time comparing to other sites (6-12 months) which make them more prone to infections and abscesses' formation. At the time of this paper, there were only 10 other scientifically published cases, most treated with antibiotics but 70% requiring incision and drainage, aspiration plus antibiotics driven by culture with sensitivities. An important differential diagnosis is inflammatory carcinoma and it demands skin biopsies after an inconclusive ultrasound (86). There is not much information of possible effects of piercings on lactation however theoretical scar tissue development could impair breastfeeding (6).

Jewellery inserted to the genitals are more vulnerable to serious infections as the area is perfect for the proliferation of periurethral microflora (89). Genital piercing vary in healing time but can take up to one year until effective skin cicatrisation. Genital piercings tend to be associated with complications that may be common to all piercings but also specific to this type (91).

For men, the penis is the usual pierced site. The most common piercing is 'the Prince Albert' which goes through the urethral meatus (90) and may interrupt urinary flow (6). Other male genital piercings complications include urethral rupture, paraphimosis (in uncircumcised men) and priapism. Traumatic accidents could be worsened and associated with damage to nerves and vessels. Infertility may happen after infections and scar formation may lead to urethral obstruction (89). Some cases require emergency treatment in order to preserve erectile function (6) for example Fournier's gangrene leading to septicemia and disseminated intravascular coagulation (DIC) (14).

Squamous cell carcinoma has also been reported in association with 'the Prince Albert piercing' but it is not clear whether it was due to the inflammation from the procedure or to the patients' own comorbidities (91).

For women with genital piercings the most common site is around the clitoris. Complications are mainly associated with numbness or pregnancy specificities. For both genres there is the possibility of dislodging diaphragms and damaging condoms which may lead to unwanted pregnancies and sexually transmitted diseases (89).

With tattoos and other piercings locations, all of which are invasive procedures, there is the chance of HBV, HCV and HIV transmission. Yet in those with genital piercings few actual cases have been reported (90).

In general, genital piercings can cause complications due to poor technique during the procedure, defective aftercare, body modifications after the piercing and/or partner damage (90).

3.9. Contra-indications

In both tattoos and piercings there are specific clinical peculiarities that must be considered prior to any definitive procedure. Underlying clinical status may cause the tattooing or piercing process to be problematic and costumers should be advised against them (58).

The European Commission summarised most contra-indications for tattooing in its report from 2016 (47):

- Bearing in mind the possibility of a tattoo masking a malignant lesion, the area to be tattooed should be free of pre-existing naevi or other pigmented lesions besides the patient having no history of melanoma or atypical lesions.
- Hypersensitivity to nickel, latex and other chemicals used in tattoo inks may be reactivated through the injection of dyes in the skin. The healing process can also be more complicated in those with skin issues (eg. eczema).
- Tattoos can act as triggers in chronic skin disorders (the Köebner phenomenon) such as psoriasis and vitiligo. Prior latent cutaneous herpes lesions can also be reactivated by tattoos.
- Those with pre-existing cardiac valve conditions (1% of the general population) have reason to avoid tattoos or at least to perform them under strict antibiotic umbrella due to the possibility of bacterial endocarditis.
- Haemophilic patients or those with coagulation disorders (thrombopenia, von Willebrand disease, etc) should seek medical approval prior to receiving tattoos as they may develop extensive bleeding secondary to the needle injury.
- Immunosuppressed and diabetic people are ill-advised to have tattoos due to their increased risk of getting an infection or having delayed wound healing time either during application or removal.

- Underlying autoimmune systemic diseases (sarcoidosis, lupus erythematosus, etc.) or treatment with interferon, might trigger delayed flaring of the latent disease within the tattoos.
- Pregnant or breastfeeding women should avert these procedures as a general preventive measure although no specific risk has been shown.

In spite of these contra-indications being relative and no legal enforcement is of yet generally applied, they have extreme importance in the safe practice of these body art procedures. Kluger et al (60) shared a fatal case of a 26-year-old man with a history of treated acute myeloid leukaemia who developed a large skin ulceration over a tattoo that had been done 10 days earlier. The patient had a relapse of the leukaemia and died of septic shock. This case underlines the utmost importance of those with chronic disorders to seek advice prior to tattooing.

Similarly, piercings are an invasive accessory and as such should be contraindicated in pregnant women, immunocompromised patients and those with known skin lesions (keloid formation, infectious dermatitis, atopic dermatitis, and dermatographism). Body piercers should ask for their costumers' medical history to identify possible risk factors. Individuals with blood dyscrasias, congenital heart disease or under anti-coagulants should be denied (10). Although the American Heart Association guidelines do not specifically mention the need for antibiotic prophylaxis in people contemplating ear or body piercings it should be considered in those with moderate to high-risk cardiac conditions (6).

3.10. Body art removal

Tattoos are by definition a permanent procedure (16). However, with the increasing prevalence of the tattooed population there has been an increased interest in tattoo removal (6), motivating the progression of removal techniques (16). In 2012, the Harris Poll reported that 14% of individuals regretted getting a tattoo (30). Although it can be necessary as treatment for complications (92), major motifs are social or aesthetic reasons, including never having been pleased with a tattoo, embarrassment or shame and professional reasons (16). In his review, Kluger et al (16) reported that in a population of college students, 13% did not like their first tattoo, 18% found the artist did not meet their expectations and 22% were not happy with one or more of their tattoos. Laux et al (48) later reported that clinical surveys indicated up to 50% of the tattooed population had second thoughts after their decision. However from these only a few would go forth with the removal because of its high costs and risks of complications (48).

Several different modalities have been developed with this purpose: salabrasion (dermabrasion using salt), dermabrasion, chemical destruction, cryosurgery, electrosurgery, surgical removal and induction of cutaneous inflammatory response (eg. with trichloroacetic acid or lactic acid) though laser treatment has become the gold standard (2, 6, 17, 48, 92).

The principle of this method is simple, a selective photothermolysis that destroys cells and connective tissue that match the characteristics of the different pigments or dyes and cleaves the pigments into smaller pieces (2). There are three types available, Q-switched ruby version, the Q-switched Nd:YAG laser and the Q-switched alexandrite laser, each with its own preferable range (colour) of action (48). These treatments are administered monthly to allow the skin time for healing and pigment clearance (2), but usually four to ten sessions are needed to sufficiently remove the design. Nonetheless, this may never be achieved especially for multi-coloured tattoos (48). As this is a process that is influenced by numerous factors (skill of the tattooist, type of equipment, etc) a scoring system was created in which all dependent factors are ranked. This score is called the Kirby-Desai scale which allows an estimation of the number of treatments likely to be required for optimal removal (2).

Just as in tattoos, their removal are not innocuous procedures and complications have been well documented over time (92). The degradation products could lead to unforeseen immune manifestations like lymphadenopathies and allergic reactions (48). Immediate effects include pain, blistering and pinpoint haemorrhages, whilst delayed ones are also significant with pigmentary changes, hypopigmentation and hyperpigmentation, burns, scarring and textural changes (17). Laser treatments in particular can lead to paradoxical darkening of cosmetic tattoos, a laser-induced photochemical change that affects mostly red, white and brown pigments (92). There have been reports of needing new tattoos to hide the burnt area. Longer intervals between sessions may reduce the risk of such permanent pigmentary changes to the skin (6).

As such, before making any decision, adolescents should see tattoos as a permanent form of body art for which their complete removal is expensive and not typically achieved. According to the AAP, a tattoo that is 15 square inches is estimated to require 8 sessions and to cost a total of 5880\$ assuming 49\$ per square inch to be removed (43).

Still, these methods are in constant evolution. Recent advances include a project developed at the Duke University in the USA, which focused on encapsulated tattoo inks. These could be disrupted through the application of a specific exogenous energy pulse and were designed to correct the position of medical nipple tattoos during the course of breast reconstruction (48).

Piercing removal, on the other hand, is mostly uneventful and one of the main attractions in its use in the younger population. If complications arise removal of the piercing is usually sufficient to close the hole and heal the wound (93). Sometimes surgical interventions may be required, mainly with genital piercings but also when earrings become embedded in the earlobe, for example. The first option is through gentle probing. If it fails then a small incision under local anaesthesia (without epinephrine) may be necessary to locate and remove the earring; any suspected infection would be treated as well (6).

3.11. Knowledge of complications

Risk perception is a highly debated theme and many consider it to be the main strategy in the reduction of body art's complications. Several studies aim to assess the knowledge on medical risks between tattooed/pierced individuals versus non-tattooed/-pierced individuals, and the same with piercings (47). Most are designed to consider several variables: general opinion about body art, knowledge about their safety and impact on medical procedures, problem of infections, complications, and contraindications associated with tattooing (93).

Studies focusing on the perception of the risks for both tattoos and piercings have similar results. Regardless of the studied population, most respondents had very little knowledge of the health risks and complications associated with body art (5, 22, 25, 93).

One article in particular focused on college students from the University of Gdansk, in Poland, and divided its sample into medical and non-medical students. This allowed for the evaluation of general knowledge versus clinical knowledge (5). In this paper, only 29% of 1199 respondents were aware that tattoo complications could occur regardless of a good compliance with hygiene measures by the tattoo artist. Also, from those already with tattoos, 67% believed that tattoos could not interfere with certain diagnostic and therapeutic procedures including magnetic resonance imaging, surgeries, or even with the diagnosis of melanoma and skin cancers. From these, 45% studied in the Medical University. What was also highlighted here was that 50% of tattoo artists did not ask their costumers about any chronic diseases or current state of health. From these results, it was understood an insufficient recognition of most tattoo problems. Medical students, due to their specific educational background, ranked better than the others.

The same conclusions were reached by Rahimi (25) however he also considered age, gender, level of education and tattoos' characteristics. Regarding sexes and different ages groups no significant differences were found, but those with a higher level of education and bigger tattoos were better informed of the implications due to body art.

Breuner et al (6) asked adolescents to estimate the chance of having a health-related problem in relation to piercings. He disclosed that the perceived risk for piercings done by a professional (34%) was lower compared with a nonprofessional (73%), but that those who had pierced themselves did not find it as risky as those who went to professionals. In this analysis there were no effects on the results due to race, sex or age.

A factor that is also associated with the knowledge of complications is the decision-making process in itself. A study regarding medical students from Brazil attended to this point. It stated that when considering the piercing procedure, 50% of students did not seek any information, 34.5% sought information on the Internet, 22.4% talked about the question with friends and only 8.6% requested information from physicians. Parental advisory was only searched in 26% of students (10).

The subjects for which people are most uninformed are ink components and their safety, adverse health effects of tattoo application and removal and prior aggravating medical conditions possibly contra-indicating any kind of invasive procedure (47).

3.12. Clinical and educational management

Nowadays, those who are most interested in body art are the young population, those below 29 years old (47). In his study, Purim et al (10) associated adolescence with piercings as they were all from before university admission. As such, when dealing with body art the focus is mainly on this age group in order to better control the safe practice of these procedures and to decrease reports of complications (26).

Bearing this in mind, several reports have been released trying to instruct the population and medical staff on how to deal with this growing trend and prevent it from becoming a public health threat (26, 43, 47, 58, 94).

Firstly, adolescents and their families must understand that there are contra-indications to body art (58). Not only it is a permanent procedure for which removal is difficult and expensive, but there are some chronic conditions which can be seriously aggravated when ignored. These contraindications also play a determining factor to the success of the procedures. Whenever there is trauma to the skin resulting in scar, paediatricians should advise adolescents with a history of keloid formation to avoid body modifications that puncture the skin (6). Customers are also responsible for assessing the quality of the establishment and of the artist which they seek and for confirming the use of sterile equipment and unused ink according to the national regulations in order (6, 26, 43).

However, lack of knowledge on the topic was the key cause for infection (26) and where most strategies address the problem. The current paradigm of non-existent straightforward and specific instructions for body modifications exposes costumers to the vulnerability of procedures performed by unqualified personnel and it must be corrected (10).

Most literature agrees that the focus is on health promotion strategies. These should be adopted by professionals such as teachers, nurses, physicians and others who are in contact with young adults to help them with their decision-making process (10, 93). Additional information campaigns and educational programs would help improve the safety of tattoos and piercings especially by addressing the public and health care professionals with the most problematic topics: tattoo artists, inks and pigment manufacturers (47). It should also be noted the implications that body art can have in a personal and professional level. They demand maintenance and care for the wound, and could inclusively have an impact in job placement (6).

Despite some studies no longer supporting a blatant relation between body modifications and high-risk behaviours (43) it still calls for underlying psychiatric assessments, avoiding labelling and solely focusing on thorough and appropriate health education (18). Brooks et al. (95) advocated that body modifications could be a marker for risk behaviours but only if in-office questionnaires advocated the same result, and not as a direct relationship. Nonetheless, other findings consider tattoos and body piercings as visual markers of alcohol, drugs, smoking and externalizing problems (31, 41, 42). Physicians should carefully examine and assess adolescents for possible inter-play between body art and psychopathology (39).

On his paper, Quaranta et al (93) proposed collaborative educational programs between body artists and schools, sharing information about body art in general and revealing the inherent risks, and encouraging young adults to contemplate their decisions carefully in advance. This goes in line with the view that tattoo artists are one of the main points of prevention and tertiary care for their costumers (94). They develop a relationship with their costumers which resembles the one between doctor and patient. In this study it was understood that when artists have professional education then screening of pre-existing skin conditions, checking for atypical moles and sharing aftercare instructions is included in the process. The same was not reported in tattooists with no prior training.

Therefore, it should be requested that everyone applying for a tattoo license understand the strict hygiene standards, specific requirements for tattoo parlours, and mandatory education on blood borne pathogens (4). On the other hand, reporting

complications resulting from body art should be imperative, just as in drug-induced adverse events (4, 47). Kluger et al (84) even suggests adding tattoo data to national skin cancer registries and standardizing ink components.

Addressing tattoos in specific, there are various options when treating its consequences. Measures can be more conservative or more invasive depending on the complication itself, its severity and location. Many situations oblige referring to the area of Dermatology (4). First line treatments usually involve topical steroids, intralesional and systemic steroids, and avoidance of UV light but invasive measures may imply the removal of the tattoo. The type of removal is determined on a case-by-case approach (4). In more emergent situations, physicians must be able to deal with acute complications and recognise potentially life-threatening situations (60).

As for piercings, as many are reported to the oral and peri-oral site, management strategies imply the coordination of paediatricians and dentistry community (7). Dental care clinicians are on the first line to offer information regarding safe piercings and correct aftercare (8) but paediatricians must also be able to educate and advise on the best possible care, i.e. informing those with piercings that during contact sports all jewellery should be removed to avoid endangering the wearer and potentially other players (6).

Inclusively, a study by McBride reviewed the AAP's report on 'Clinical guidance to tattooing and piercing among youth' (43). Not only did they comment on the types and methods of body modification along with all aspects adjourned to it, but also developed practical advice to give to patients and families. One of the key points taken into consideration is the necessary deferral from donating blood post invasive procedures, which was also reviewed by several other studies (96).

In medical literature, understanding if tattoos performed in licensed premises are a risk factor for blood-borne viruses has resulted in conflicting evidence (82). Jafari et al. (96) ascertained an increased risk of hepatitis C infection among those tattooed, which Hoad et al. (97) counterposed with the difficulty to establish causal association and to interpret results excluding confounding factors. In her study, she established a low, albeit not zero association. Her aim was to review Australia's blood donor deferral of 4 months after body modifications. She concluded that ceasing such deferral would not lead to unacceptable risk as there are strict hygiene guidelines for tattoo and piercing practices (although she recommended screening for asymptomatic bacteraemia beforehand). In line with this conclusion, Urbanus et al (82) proved that by having a tattoo or a piercing performed in a professional parlour respecting strict conditions of asepsis, is not a risk factor for hepatitis. As

such, there is no need for screening for HBV and HCV in those with tattoos or piercings in the Netherlands. On the other hand, in the United States, there is a 12 month wait before donating blood after obtaining a tattoo or piercing to assure no transmission of hepatitis B or C (43). In 2010, HCV was the most common chronic blood-borne infection and the leading indication for liver transplantation, having an important clinical and public health impact (96).

Conflicting findings mirror the diversity of populations studied and how risk varies according to different behaviours, i.e. tattoos in prisons versus professional parlours (57, 83). Considering the best available evidence today there is still an understanding that needle treatments are too big of a risk factor to be neglected. This is extremely important when donating blood to ensure and maximise the safety of patients who will receive it (98).

In both tattoos and body piercings it is the physicians' responsibility to know local regulations and health measures, should their patients be interested in obtaining either of them (6).

4. DISCUSSION

Summary of main results ascertain that the key issue with body modifications is the lack of knowledge there is towards most of its aspects: whether it is in regard to tattoo inks, the particularities of henna tattoos, legal regulations, contraindications or health problems.

Adolescents, an age group which includes those under 18 years old and college students, are unquestionably the most studied group of interest. They see themselves as 'risk takers', ignoring parental advisory and making impulsive and definite decisions (18). As such, they might go forth with procedures they do not fully understand and in the future must lead with consequences and implications that they did not expect.

To change their behaviours is to understand their motivations, and social norms play an important role in shaping personalities and influencing decisions (99). Understanding societal perceptions on body modifications is understanding the recent increase in its prevalence and even though many behaviours are personally driven, they are also dictated by the environment and subjected to societal factor.

What was in the past synonym to high-risk behaviours today is less consistent (16). Most tattoos and piercings are fashion statements, fluid concepts which may be associated with showing one's independence, individuality and values, or have no secondary meaning at all (2). However, and despite public acceptance of such procedures, it is still connected to some stigma and might affect work prospects – the young population today should bear this in mind and understand that they may not be able to control how they are perceived in some situations (6).

On the other hand, whilst most people assume that there are governmental laws to regulate these practices, there is an obvious legal gap in most regulatory issues. If there are no procedural obligations this endangers the health of consumers and tattooists/piercers will hardly be held responsible if something goes wrong. In a way, it undoes the quality of good professionals who invest in appropriate conditions and training (56).

In fact, the increasing proportion of tattooed individuals all over the world, particularly in the young generations, is raising concerns to the public health system as the prevalence of tattoo-related problems has grown together with the number of tattoos applications and removals (47). And whilst most parlours do forbid underage procedures,

teenagers lie about their age or go to those who do not ask for any personal information (2). Such high demand allowed for the opportunity of unauthorised facilities to profit, increasing the risk for adverse events.

From the reported medical literature, it can be understood that results cannot be interpreted in any light other than the context in which they have been applied and that means different populations might lead to different conclusions. The development of tattoo inks and the tattoo businesses at the time of the reports should always be taken into consideration. Literature focusing only on tattoos is greater than the one on piercings, but results are similar.

Body modifications can result in a wide variety of complications. Indeed, they have been recorded since the end of the 19th century but its patterns keep adapting to medical progresses and to the evolution of fashion (23). Most complaints are minor and self-limited and, when not, adolescents are reluctant to seek medical attention. Therefore, there is a clear limitation in studies focusing on health consequences which prevents from accurately determining its prevalence and incidence (60, 74). Nonetheless, body art cannot be considered innocuous as its adverse effects on health are a probable consequent issue. Chronic reactions like itching, stinging and pain, which are highly reported, should not be underestimated. In fact, they can be considered as cumbersome dermatological diseases and must be given priority attention and qualified treatment by the public health care system. People could be expected to deal with such symptoms for years (62).

Current literature states that infections are mostly related to the lack of asepsis and hygiene during the procedure or during the aftercare. However, this could be avoided by educating and training of professionals and by customers following carefully the existing protocols (2). In Europe, the CoE ResAP guidelines were thought bearing in mind everyone's best interests and by abiding to them the 3 potential origins of infection could be averted (45). The fact that some countries have positively changed their epidemiological status, such as the Netherlands and Germany, reveals the importance of implementing these measures to assure the safe practice of body art procedures (49, 55, 82). This way, the emerging problematic of clusters of NTM infections and antibiotics resistance might be controlled before majorly affecting public health (78).

Another important issue is the chance of developing a coincidental malignancy on a tattoo or how tattoos may compromise the clinical and dermatological control of skin lesions or even how they can be the triggering factor for cancer development (23). Nevertheless, the true risk of tumours remains difficult to assess due to the scarcity of epidemiological data,

multiple confounding social and environmental factors and the long latency period for local or systemic cancers plus the constant renewal of inks' compositions (2). As such, what young people do today on their bodies could on the future have severe consequences (47).

From this review what was understood to be more relevant for the risk of infection and for adverse effects in general, is the ignorance on the topic especially on ink components and their safety, adverse health effects of tattoo application and removal, and prior aggravating medical conditions possibly contra-indicating any kind of invasive procedure (29). Indeed, for both tattoos and body piercing, specific contra-indications have been reported for which most people are unaware. Underlying clinical status and medical background must be evaluated prior to any definite procedure in order to prevent problematic procedures (47). In fact, better outcomes can be expected when the target (represented by young subjects) is made aware of possible risks and consequences.

For example, if a patient has already experienced a reaction to a colour, he/she should clearly be discouraged from having a new tattoo with similar colours, even if the tattooist uses another brand (45). Also understood from previous reports, hypersensitivity reactions are not predictable and the typical screening tests are not useful for its diagnosis (74). Patients with chronic conditions and/or impaired immunity should discuss with their physician about the possibility and when to have a tattoo/body piercing (29). Henna tattoos are another easy example. Many parents are unaware of their hazards and may unknowingly allow their children to participate in this cosmetic novelty trend (50). To avoid the described effects of these temporary tattoos, considered as a harmless vanity and moment of fun during an exotic holiday, it would be desirable for both scientific associations and individual specialists in dermatology, allergology and paediatrics to set up a massive preventive campaign warning of the risks and dissuading young travellers from indulging in such practices while abroad (51).

To diminish unwieldy consequences the focus is on health promotion strategies. Prevention, by definition, is the promotion of health by the individual and the community and identifies the risks while intervening to correct or minimize its consequences. Primary prevention in body art includes controlling the victim's exposure to microorganisms and educating communities and individuals on awareness and safety practices (26). This way, infectious events and other complications, sometimes severe or fatal, can be averted.

More than the economic impact and global burden of reactions, which remains minimal, is the personal effects they may have. Therefore, besides educational campaigns (58), a standardized medical consult should be created for adolescents to undergo careful

physical and psychological evaluation prior to any body modification so to assess skin lesions or other underlying comorbidities and also risk-behaviour tendencies (26).

What best mirrors the importance of these procedures and the impact it can have on health is the fact that even considering the best available evidence, the risk of infection is too big to be ignored in blood donations (98).

5. CONCLUSION

Acknowledging the results of this review, the topic of body modifications has a great impact in the young population of today. Adolescents are people of strong internal image and identity strength, trying to show their independence by advocating the ownership of their own body. Instead of battling this, medical focus should be on assuring best clinical care and preventing complications or chronic manifestations from both tattoos and body piercings.

The topic of body modifications must be given priority attention and qualified treatment by the public health care system with the action of a multidisciplinary medical team: paediatricians, dermatologists, dentists and psychiatrists.

Further longitudinal studies documenting body art consequences would be insightful, mainly considering the possibility of malignancy development as there will only be useful data years from now.

6. TAKE HOME MESSAGES

1. Tattooing is an increasing fashion phenomenon which already involves over millions of Europeans. Numbers are even higher for piercings.
2. Body modification should not be confused with non-suicidal self-injury (NSSI) and paediatricians must recognize the differences between voluntary body modifications and this impulsive syndrome.
3. Recent data no longer supports the concept that body modification is strongly associated with high-risk behaviours. However individuals with four or more tattoos, seven or more piercings, and/or intimate piercings had significant differences regarding risky behaviour, emotional distress, and self-view.
4. As adolescents, their decisions can have significant consequences in the future, so it is recommended a careful conversation with their parents, guardians, or other responsible adults before having any procedure, either tattoos or piercings.
5. Adolescents and their families should be informed that tattoos are permanent and that removal is difficult, expensive, and only partially effective. Adolescents should be counselled about the implications on job placement if the tattoos or piercings are at all visible.
6. Paediatricians and dentists should advise their patients to avoid any invasive procedures if presenting specific clinical peculiarities and suffering of different disorders, at dermal, oral or systemic level.
7. Clinicians should advise their adolescent patients to assess the sanitary and hygienic practices of the tattoo parlours and artists. This would include observing the use of new, disposable gloves; the removal of the new equipment from a sealed, sterile container; and the use of fresh, unused ink poured into a new, disposable container with each new client.
8. Immediately after a tattoo, special precautions must be taken regarding sun exposure and clothing, as sun should be avoided and clothes must not adhere to the skin(6). Rinsing with non-prescription oral cleansers or the topical application

of cleansers is also recommended to prevent infection after oral piercing. These are advices that tattoo artist or piercers must also transmit to their customers.

9. Paediatricians should advise adolescents to seek medical care if there are signs and symptoms of infection or allergic reactions.
10. Additional information campaigns on risks, targeting teenagers and young people should be undertaken, allowing for an informed choice.
11. Medical staff should be informed about local laws and regulations related to body art should paediatric patients be interested in having them performed.

ANNEX I

Table 1 Tattoo types

Type	Characteristics	Motivation	Special consideration
Professional	Uniformly deep, dense dermal injections of pigment Often multicolor	Self-expression Commemoration of significant life event Group affiliation	Removal may be challenging, especially if multicolor
Amateur	Fewer pigment particles than professional Placement more superficial than professional Usually one color	Similar motivation to professional, but more likely to be performed in limited-resource settings or incarceration	Removal is often easier than professional Greater risk of infection
Cosmetic	Permanent makeup applied freehand, typically by cosmetologist or esthetician Adjunct to reconstructive surgery, especially of the face or breast Camouflage for chronic skin conditions (eg, depigmentation, scars, striae, alopecia)	Time saving Popular with those with health conditions that create barriers to makeup application, eg, visual impairment, tremors, osteoarthritis, myopathy Nipple and areolar tattoos may add significantly to quality of life and positive body image for women undergoing breast cancer treatment and breast reconstruction	Removal of permanent makeup is very challenging because of composition of pigments used Changes in aging skin may lead to alterations in permanent makeup location (alteration in fullness of lips or eyelid contours) Age-related changes in skin tone or hair color may lead to dissatisfaction with tattoo coloration Tattoo colors will fade, and lines will blur with time
Medical	Radiation markers similar to amateur in terms of technique and materials	Marker for radiation Alternative to medical alert jewelry for those with life-threatening conditions (eg, diabetes, Addison's, hypothyroidism, epilepsy, severe allergy)	Radiation marker tattoos are typically easy to remove
Traumatic	Result of blast or road surface trauma	Accidental	Particles may include metal, glass, dirt, and/or carbon-containing particles Difficult to remove
Temporary	Not intended to be permanent Emerging technologies include wearable sensors	Henna-based temporary tattoos may be purely decorative or have ritual meaning Rub-on tattoo decals are decorative Wearable sensors can monitor electrolytes and metabolites for health purposes	Although henna rarely causes allergy, hypersensitivity to adulterants may occur Highly toxic PPD is frequently added to henna: strongly suspected to be carcinogenic, known allergen Metal-based rub-on tattoos may cause hypersensitivity

Abbreviation: PPD, paraphenylenediamine.

Source: Farley CL, Van Hoover C, Rademeyer C-A. Women and Tattoos: Fashion, Meaning, and Implications for Health. *Journal of Midwifery & Women's Health*. 2019;64(2):154-69 (2)

References

1. Kluger N. Insights into Worldwide Interest in Tattoos Using Google Trends. 2019(1421-9832 (Electronic)).
2. Farley CL, Van Hoover C, Rademeyer C-A. Women and Tattoos: Fashion, Meaning, and Implications for Health. *Journal of Midwifery & Women's Health*. 2019;64(2):154-69.
3. Tomažević T Fau - Gašperšič R, Gašperšič R Fau - Kosem R, Kosem R. Occurrence of Dental Injuries and Periodontal Complications in Tongue-piercing Jewellery Users. 2015(1602-1622 (Print)).
4. Islam PS, Chang C, Selmi C, Generali E, Huntley A, Teuber SS, et al. Medical Complications of Tattoos: A Comprehensive Review. 2016(1559-0267 (Electronic)).
5. Rogowska P, Szczerkowska-Dobosz A, Kaczorowska R, Słomka J, Nowicki R. Tattoos: Evaluation of knowledge about health complications and their prevention among students of Tricity universities. *Journal of cosmetic dermatology*. 2017;17(1):27-32.
6. Breuner Cc Fau - Levine DA, Levine DA. Adolescent and Young Adult Tattooing, Piercing, and Scarification. LID - e20163494 [pii] LID - 10.1542/peds.2017-1962 [doi]. 2017(1098-4275 (Electronic)).
7. Pires ILO, Cota LOM, Oliveira ACB, Costa JE, Costa FO. Association between periodontal condition and use of tongue piercing: A case-control study. *Journal of Clinical Periodontology*. 2010;37(8):712-8.
8. Hennequin-Hoenderdos NL, Slot DE, Van der Weijden GA. The prevalence of oral and peri-oral piercings in young adults: a systematic review. *International journal of dental hygiene*. 2012;10(3):223-8.
9. Bui E, Rodgers R Fau - Simon NM, Simon Nm Fau - Jehel L, Jehel L Fau - Metcalf CA, Metcalf Ca Fau - Birmes P, Birmes P Fau - Schmitt L, et al. Body piercings and posttraumatic stress disorder symptoms in young adults. 2012(1532-2998 (Electronic)).
10. Purim KS, Rosario BA, Rosario CS, Guimarães AT. Piercings in medical students and their effects on the skin. 2013(1806-4841 (Electronic)).
11. Goldstein N. Tattoos defined. *Clinics in Dermatology*. 2007;25(4):417-20.
12. Oberholzer TG, George R. Awareness of complications of oral piercing in a group of adolescents and young South African adults. *Oral Surgery, Oral Medicine, Oral Pathology, Oral Radiology and Endodontology*. 2010;110(6):744-7.
13. Tubek K, Berus T, Leszek R. The girl with the eyeball tattoo-what the ophthalmologist may expect? Case report and a review of literature. *European Journal of Ophthalmology*. 2018(1724-6016 (Electronic)).
14. Perry M, Lewis H, Thomas DR, Mason B, Richardson G. Need for improved public health protection of young people wanting body piercing: evidence from a look-back exercise at a piercing and tattooing premises with poor hygiene practices, Wales (UK) 2015. 2018(1469-4409 (Electronic)).
15. Manso MA-O, Pessanha S, Guerra M, Reinholz U, Afonso C, Radtke M, et al. Assessment of Toxic Metals and Hazardous Substances in Tattoo Inks Using Sy-XRF, AAS, and Raman Spectroscopy. 2018(1559-0720 (Electronic)).
16. Kluger N. Epidemiology of tattoos in industrialized countries. Karger Publisher. 2015(1662-2944 (Electronic)).
17. Shashikumar BM, Harish MR, Shwetha B, Kavya M, Deepadarshan K, Phani HN. Hypersensitive Reaction to Tattoos: A Growing Menace in Rural India. 2017(1998-3611 (Electronic)).
18. Owen Dc Fau - Armstrong ML, Armstrong Ml Fau - Koch JR, Koch Jr Fau - Roberts AE, Roberts AE. College students with body art: well-being or high-risk behavior? 2013(0279-3695 (Print)).
19. Van Hoover C Fau - Rademayer C-A, Rademayer Ca Fau - Farley CL, Farley CL. Body Piercing: Motivations and Implications for Health. (1542-2011 (Electronic)).

20. PewResearchCenter. Millennials: Confident. Connected. Open to Change. USA: PewResearchCenter; 2010.
21. Serup J, Carlsen Kh Fau - Sepehri M, Sepehri M. Tattoo complaints and complications: diagnosis and clinical spectrum. 2015(1662-2944 (Electronic)).
22. Cegolon L, Miatto E, Bortolotto M, Benetton M, Mazzoleni F, Mastrangelo G, et al. Body piercing and tattoo: awareness of health related risks among 4,277 Italian secondary school adolescents. BMC public health. 2010;10:73.
23. Kluger N. Cutaneous and systemic complications associated with tattooing. 2016(2213-0276 (Electronic)).
24. Show KL, Le Win L, Saw S, Myint CK, Than KM, Oo YTN, et al. Knowledge of potential risk of blood-borne viral infections and tattooing practice among adults in Mandalay Region, Myanmar. PLOS ONE. 2018;14(1):e0209853.
25. Rahimi IA, Eberhard I, Kasten E. TATTOOS: What Do People Really Know About the Medical Risks of Body Ink? 2018(1941-2789 (Print)).
26. Majori S, Capretta F, Baldovin T, Busana M, Baldo V, Collaborative G. Piercing and tattooing in high school students of Veneto region: prevalence and perception of infectious related risk. 2013(1121-2233 (Print)).
27. Barnhart R, Steinmetz S. Chambers Dictionary of Etymology. Edinburgh: Chambers.1999 1320 p.
28. Pesapane F, Nazzaro G, Gianotti R, Coggi A. A Short History of Tattoo. JAMA Dermatology. 2014;150(2):145-.
29. Kluger N. An update on cutaneous complications of permanent tattooing. 2019(1744-8409 (Electronic)).
30. Braverman S. One in Five U.S. Adults Now Has a Tattoo. New York: The Harris Poll; 2013.
31. Bui E, Rodgers R, Cailhol L, Birmes P, Chabrol H, Schmitt L. Body piercing and psychopathology: a review of the literature. Psychotherapy and psychosomatics. 2010;79(2):125-9.
32. Fell MMA. The Understanding the Impact of COVID-19 on the Emerging Generations. Suite 105, 29 Solent Circuit Norwest NSW 2153 AUSTRALIA: McCrindle Research Pty Ltd; 2020.
33. Shannon-Missal L. Tattoo Takeover: Three in Ten Americans Have Tattoos, and Most Don't Stop at Just One New York: *The Harris Poll* 2016.
34. Kluger N. Tattoos among Professional ATP and WTA Tennis Players. Dermatology. 2018;136(3):229-31.
35. Kluger N. Tattoos among athletes: a matter of concern? J Sports Med Phys Fitness. 2020.
36. Kluger N, Samimi M. Tattoos among elite football players during the 2018 FIFA World Cup Russia. J Eur Acad Dermatol Venereol. 2019;33(3):e132-e4.
37. Huettel SA, Kranton RE. Identity economics and the brain: uncovering the mechanisms of social conflict. Philosophical Transactions of the Royal Society B: Biological Sciences. 2012;367(1589):680-91.
38. Heywood W, Patrick K, Smith AM, Simpson JM, Pitts MK, Richters J, et al. Who gets tattoos? Demographic and behavioral correlates of ever being tattooed in a representative sample of men and women. Ann Epidemiol. 2012;22(1):51-6.
39. Ekin O, Topcuoglu V Fau - Sabuncuoglu O, Sabuncuoglu O Fau - Berkem M, Berkem M Fau - Akin E, Akin E Fau - Gumustas FO, Gumustas FO. The association of tattooing/body piercing and psychopathology in adolescents: a community based study from Istanbul. Springer Science+Business Media. 2012(1573-2789 (Electronic)).
40. Yen CF, Hsiao RC, Yen JY, Yeh YC, Wang PW, Lin HC, et al. Tattooing among high school students in southern Taiwan: the prevalence, correlates and associations with risk-taking behaviors and depression. Kaohsiung J Med Sci. 2012;28(7):383-9.
41. Guéguen N. Tattoos, piercings, and alcohol consumption. 2012(1530-0277 (Electronic)).
42. Guéguen N. Tattoo, piercing, and adolescent tobacco consumption. 2013(0334-0139 (Print)).

43. McBride DL. Clinical Guidance to Tattooing and Piercing Among Youth. *Journal of pediatric nursing*. 2018;39:83-4.
44. Copyright. *Diagnostic and Statistical Manual of Mental Disorders*. DSM Library: American Psychiatric Association; 2013.
45. Wenzel SM, Rittmann I, Landthaler M, Bäuml W. Adverse Reactions after Tattooing: Review of the Literature and Comparison to Results of a Survey. *Dermatology*. 2013;226(2):138-47.
46. Schreiver I, Hesse B, Seim C, Castillo-Michel H, Anklamm L, Villanova J, et al. Distribution of nickel and chromium containing particles from tattoo needle wear in humans and its possible impact on allergic reactions. *Particle and Fibre Toxicology*. 2019;16(1):33.
47. Paola P, Sazan P, Laura C, Ivana B, Chiara S. Safety of tattoos and permanent make-up. protection Hac; 2016.
48. Laux P, Tralau T, Tentschert J, Blume A, Dahouk SA, Bäuml W, et al. A medical-toxicological view of tattooing. *Lancet*. 2016;387(10016):395-402.
49. Serup J. Tattoo Infections, Personal Resistance, and Contagious Exposure through Tattooing. 2017(1662-2944 (Electronic)).
50. de Groot AC. Side-effects of henna and semi-permanent 'black henna' tattoos: a full review. 2013(1600-0536 (Electronic)).
51. Calogiuri G, Foti C, Bonamonte D, Nettis E, Muratore L, Angelini G. Allergic reactions to henna-based temporary tattoos and their components. *Immunopharmacology and immunotoxicology*. 2010;32:700-4.
52. GLG V, OG A, RA F. Allergic Contact Dermatitis. A Case Due to a Henna Tattoo. *Dermatología Cosmética, Médica y Quirúrgica: Dermatología Cosmética, Médica y Quirúrgica*; 2018. p. 281-5.
53. Barea EC, Andonegui MG, Figueroa BG. Reacciones a seudotatuajes de henna. Sensibilización alérgica a parafenilendiamina. Elsevier España,S.L; 2013. p. 269-70
54. Environmental Health Association N. BAMC BODY ART MODEL CODE. 2019.
55. Schmidt A. Hygiene standards for tattooists. 2015(1662-2944 (Electronic)).
56. Ramos F. Tatuagens à espera da lei. Portugal: DECO Protest; 2018.
57. Bicca JF, Duquia RP, Breunig Jde A, de Souza PR, Almeida HL, Jr. Tattoos on 18-year-old male adolescents--characteristics and associated factors. *An Bras Dermatol*. 2013;88(6):925-8.
58. Piccinini P, Pakalin S, Contor L, Bianchi I. Safety of tattoos and permanent make-up. Adverse health effects and experience with the Council of Europe Resolution (2008)1. Luxembourg, protection Hac; 2016.
59. Gallè F, Quaranta A, Napoli C, Di Onofrio V, Alfano V, Montagna MT, et al. Body art practices and health risks: young adults' knowledge in two regions of southern Italy. *Ann Ig*. 2012;24(6):535-42.
60. Kluger N. Acute complications of tattooing presenting in the ED. 2012(1532-8171 (Electronic)).
61. Kluger N. Tattoo side effects worldwide: a Google Trends-based time series analysis. 2019(1581-2979 (Electronic)).
62. Carlsen KH, Serup J. Chronic tattoo reactions cause reduced quality of life equaling cumbersome skin diseases. 2015(1662-2944 (Electronic)).
63. Kluger N. Inflammation around the tattooed area a few hours after the session. In: session. Iattaafhat, editor. *Acute complications of tattooing presenting in the ED*2012.
64. Serup J, Hutton Carlsen K. Patch test study of 90 patients with tattoo reactions: negative outcome of allergy patch test to baseline batteries and culprit inks suggests allergen(s) are generated in the skin through haptization. 2014(1600-0536 (Electronic)).
65. Lopes SA-O, Baudrier T, Azevedo F. Flat-topped papules arising in a young woman's tattoo. In: tattoo F-tpaiayws, editor. Porto, Portugal2018.
66. Bosonnet S. Lympho-histiocytic reaction towards the pink color (Dr S. Bosonnet, Montpellier). In: *Lympho-histiocytic reaction towards the pink color* (Dr S. Bosonnet M, editor. Montpellier2016.
67. Hakimi S, Del Giudice P. Granulomatous reaction on the red of a tattoo. In: *Granulomatous reaction on the red of a tattoo* (Drs S. Hakimi and P. Del Giudice N, editor.

Nice2016.

68. Islam PS, Chang C, Selmi C, Generali E, Huntley A, Teuber SS, et al. Complications from cosmetic tattoo of the eyebrows. In: *eyebrows*. Cfctot, editor. USA2016.
69. Reinhart J Fau - Willett M, Willett M Fau - Gibbs N, Gibbs N. Ostraceous Psoriasis Presenting as Koebner Phenomenon in a Tattoo. 2019(1545-9616 (Print)).
70. Reinhart J, Willett M, Gibbs N. Ostraceous, scaling plaques outlining markings within the patient's recent right upper arm tattoo. In: *Ostraceous spomwtpsrruat*, editor. San Diego, CA2019.
71. Barea EC, Andonegui MG, Figueroa BG. Pápulas eritematosas, vesículas y ampollas en la zona de contacto con el seudotatuaje. In: *parafenilendiamina RasdhSaa*, editor. Spain.
72. Serup J, Carlsen KH, Sepehri M. Infectious complications of tattooing. In: *Spectrum TCaCDaC*, editor. Tattooed Skin and Health2015.
73. Porter CJW, Simcock JW, MacKinnon CA. Necrotising fasciitis and cellulitis after traditional Samoan tattooing: case reports. *Journal of Infection*. 2005;50(2):149-52.
74. Serup J, Carlsen KH, Sepehri M. Tattoo complaints and complications: diagnosis and clinical spectrum. 2015(1662-2944 (Electronic)).
75. Conaglen PD, Laurenson If Fau - Sergeant A, Sergeant A Fau - Thorn SN, Thorn Sn Fau - Rayner A, Rayner A Fau - Stevenson J, Stevenson J. Systematic review of tattoo-associated skin infection with rapidly growing mycobacteria and public health investigation of a cluster in Scotland, 2010. 2013(1560-7917 (Electronic)).
76. Scott-Lang VE, Sergeant A, Sinclair CG, Laurenson IF, Biswas A, Tidman MJ, et al. Cutaneous Mycobacterium chelonae infection in Edinburgh and the Lothians, South-East Scotland, U.K. *Br J Dermatol*. 2014;171(1):79-89.
77. Sergeant A, Conaglen P, Laurenson IF, Claxton P, Mathers ME, Kavanagh GM, et al. Mycobacterium chelonae infection: a complication of tattooing. *Clin Exp Dermatol*. 2013;38(2):140-2.
78. Kotzen M, Sell J, Mathes RW, Dentinger C, Lee L, Schiff C, et al. Using Syndromic Surveillance to Investigate Tattoo-Related Skin Infections in New York City. *PLoS One*. 2015;10(6):e0130468.
79. Atkins BL, Gottlieb T. Skin and soft tissue infections caused by nontuberculous mycobacteria. *Curr Opin Infect Dis*. 2014;27(2):137-45.
80. Conaglen PD, Laurenson If Fau - Sergeant A, Sergeant A Fau - Thorn SN, Thorn Sn Fau - Rayner A, Rayner A Fau - Stevenson J, Stevenson J. Lesions caused by tattoo-associated skin infection with rapidly growing mycobacteria from a cluster of one confirmed and three probable cases, Scotland, 2010. Systematic review of tattoo-associated skin infection with rapidly growing mycobacteria and public health investigation of a cluster in Scotland, 20102013.
81. Rodriguez-Blanco I, Fernandez LC, Suarez-Penaranda JM, Perez del Molino ML, Esteban J, Almagro M. Red hyperkeratotic papules restricted to the grey areas of the tattoos. In: *tattoos Mciaw*, editor. 2011.
82. Urbanus AT, van den Hoek A Fau - Boonstra A, Boonstra A Fau - van Houdt R, van Houdt R Fau - de Bruijn LJ, de Bruijn Lj Fau - Heijman T, Heijman T Fau - Coutinho RA, et al. People with multiple tattoos and/or piercings are not at increased risk for HBV or HCV in The Netherlands. 2011(1932-6203 (Electronic)).
83. Tohme RA, Holmberg SD. Transmission of hepatitis C virus infection through tattooing and piercing: a critical review. 2012(1537-6591 (Electronic)).
84. Kluger N, Koljonen V. Tattoos, inks, and cancer. *Lancet Oncol*. 2012;13(4):e161-8.
85. Kluger N. A patient with extensive tattoos on the whole back making it difficult to examine numerous moles. In: *tattooing Cascaw*, editor. 2016.
86. Kapsimalakou S, Grande-Nagel I, Simon M, Fischer D, Thill M, Stöckelhuber BM. Breast abscess following nipple piercing: a case report and review of the literature. *Archives of gynecology and obstetrics*. 2010;282(6):623-6.
87. Johansen JD, Werfel T. Highlights in allergic contact dermatitis 2018/2019. 2019(1473-6322 (Electronic)).
88. Ziebolz DA-O, Söder F, Hartl JF, Kottmann T, Rinke S, Schmalz G. Comprehensive

- assessment of dental behaviour and oral status in patients with tongue piercing-results of a cross-sectional study. Springer-Verlag GmbH. 2019(1436-3771 (Electronic)).
89. Lee B, Vangipuram R Fau - Petersen E, Petersen E Fau - Tyring SK, Tyring SK. Complications associated with intimate body piercings. LID - 13030/qt5gp333zr [pii]. 2018(1087-2108 (Electronic)).
90. Nelius T, Armstrong ML, Rinard K, Young C, Hogan L, Angel E. Genital piercings: diagnostic and therapeutic implications for urologists. *Urology*. 2011;78(5):998-1007.
91. Edlin RS, Aaronson DS, Wu AK, Blaschko SD, Yang G, Erickson BA, et al. Squamous cell carcinoma at the site of a Prince Albert's piercing. *J Sex Med*. 2010;7(6):2280-3.
92. Vakharia P, Orrell KA, Laumann AE. *Tattoo Reactions*. MedScape; 2017.
93. Quaranta A, Napoli C, Fasano F, Montagna C, Caggiano G, Montagna MT. Body piercing and tattoos: a survey on young adults' knowledge of the risks and practices in body art. *BMC Public Health*. 2011;11(1):774.
94. Rosenbaum BE, Milam Ec Fau - Seo L, Seo L Fau - Leger MC, Leger MC. *Skin Care in the Tattoo Parlor: A Survey of Tattoo Artists in New York City*. 2016(1421-9832 (Electronic)).
95. Brooks TL, Woods ER, Knight JR, Shrier LA. Body modification and substance use in adolescents: is there a link? *J Adolesc Health*. 2003;32(1):44-9.
96. Jafari S, Copes R, Baharlou S, Etminan M, Buxton J. Tattooing and the risk of transmission of hepatitis C: a systematic review and meta-analysis. *International journal of infectious diseases : IJID : official publication of the International Society for Infectious Diseases*. 2010;14(11):e928-e40.
97. Hoad VA-O, Guy RJ, Seed CA-O, Harley R. Tattoos, blood-borne viruses and blood donors: a blood donor cohort and risk assessment. 2019(1423-0410 (Electronic)).
98. Van Remoortel H, Moorkens D, Avau B, Compennolle V, Vandekerckhove P, De Buck E. Is there a risk of transfusion-transmissible infections after percutaneous needle treatments in blood donors? A systematic review and meta-analysis. *Vox Sanguinis*. 2019;114(4):297-309.
99. Rodríguez-Planas N, Sanz-de-Galdeano A. Intergenerational transmission of gender social norms and teenage smoking. *Social Science & Medicine*. 2019;222:122-32.