Ann Ig 2020; 32 (5 Suppl 1): 52-65 doi:10.7416/ai.2020.3394

Hygienic and sanitary standards of housing in Europe: a comparative analysis of nine countries

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Keywords: Building Code; sanitary requirements; housing standards; comparative analysis
Parole chiave: Regolamenti edilizi; requisiti igienico-sanitari; standard abitativi; analisi comparativa

Abstract

In recent years, growing interest was devoted to housing conditions from both scientific community and public health, so they are now considered among the main environmental and social health determinants of health of the population. Aim of the study is to analyze and compare the current regulations regarding housing sanitary requirements in different Countries of the EU (Sweden, United Kingdom, Denmark, the Netherlands, France, Germany, Portugal, Spain) with the contents of the Italian Health Ministerial Decree 5th July 1975. From the websites of the official channels of the various countries the regulations have been downloaded. For the comparison, only the aspects of BCs concerning the scale of the building were examined; the comparison concerned all the requirements of the Health Ministerial Decree of 5.07.1975 and some other parameters (e.g. indoor chemical pollution, ionizing radiation, non-ionizing radiation) not provided for in the Ministerial Decree, treated in the other standards regulations, and relevant for the indoor well-being of the occupants. The authors observe a wide variability in the contents and in the formulation of the hygienic-sanitary requirements among the different Building Codes, above all as regards the dimensional data and some fundamental themes (e.g. heating systems, mechanical ventilation) whose treatment is often not it is updated with respect to the technological-scientific innovation consolidated over the past few years.
A diverse approach among European Countries is also observed: from a market-oriented logic (e.g. UK), to a prescriptive one (Italy), to a functionality-oriented (the Netherlands). The comparative analysis we carried out made it possible to identify convergences and divergences in the standards analysed for the different European countries. As far as the Italian legislation on the usability of residential premises, finally, considering the health, social, environmental and economic trends, many standards contained in the MD 5th July 1975 should be reviewed and updated.

Introduction

In recent years, growing interest was devoted to housing conditions by both the scientific community and the Public Health operators; today, such conditions are considered among the major environmental and social determinants of health [1-4]. This is linked to a number of factors, which include: (a) the indoor exposure to chemical and biological pollutants and to physical factors [5, 6]; (b) the accumulation of scientific evidence on the health impact of inadequate housing, which is unable to cope with the

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new needs determined by the climate changes and the aging of the population; (c) the obsolescence of many buildings [1, 2, 7-14]; (d) the recovery for housing purposes of premises unsuitable for location and size (e.g.: stores, basements, garrets, etc.) [14-16].

Situations of distress occur mainly in the suburbs, where the phenomenon of illegal construction proliferates, and a significant number of people lives in precarious and unhealthy dwellings [4]. It is no coincidence that the WHO Commission on Social Determinants of Health identified daily living conditions as one of the main causes of inequality [17-21]. At the second UN Conference on Habitat in 1996, the universal goal of guaranteeing adequate housing for all, and making human settlements safe, healthy, liveable, fair, sustainable and productive was signed. It follows that the themes of housing and its quality are areas of priority interest for Public Health, since it is estimated that the inhabitants of more economically advanced countries spend more than 90% of their lifetime in indoor environments and, among those, dwellings are the most important [2, 6, 22-24].

Obviously, the concept of housing quality covers a wide range of issues, which are related not only to the dwelling itself, but also to the surrounding residential area [25, 26]. This implies the need to direct the choices towards the improvement of the overall living conditions, managing the built environment according to a new approach in which the building has to be thought in relation to the area in which it is located, not only from an environmental perspective, but also economic and social [27].

With particular regards to the factors of indoor wellbeing, many have been identified in the past two centuries by the scientific community [28, 29]. These include: lighting and sunlight [3, 30-32], temperature, humidity and air speed [3, 11, 33-35], air changes [12-13], also in relation to the presence of pollutants of physical, chemical and biological nature (radon, thorium, volatile organic compounds - VOCs, microorganisms, etc.) [4, 5, 10, 14].

Most of these elements, as well as those related to indoor comfort, have been enacted by rules and regulations at various levels: the availability of clear and updated sanitary requirement, dictated by regulations, is fundamental to effectively protect Public Health in confined environments [33-35], as demonstrated by many international studies [36, 37]. This paper is aimed at analysing, interpreting and comparing the regulations in force concerning the sanitary requirements of dwellings in different European countries with the contents of the Italian Ministerial Decree dated July 5th, 1975 titled "*Modifications to ministerial instructions June 20th, 1896 related to minimum height and main hygienic requirements of the living quarters*". This in order to update the definition of the essential elements that qualify a room as inhabitable from a hygienic and sanitary point of view, and to identify good practices and health performance targets aimed at updating building hygiene regulations.

Although aware of the non-homogeneity of the standards, as well as of the administrative and health institutions that dictated them and are in charge of their control [38-40], an attempt was made to compare the main requirements that define a living space in the countries concerned of study. It is worth remembering that so far there there are very few studies on the subject of indoor wellbeing and related regulatory requirements in both the national and international context [41, 42].

Methods

The search was performed between March and May 2018, on both general search engines (Google) and legal search engine (DeJure Giuffré) and biomedical

ones (Pubmed, Scopus). The research also involved scientific literature search engines using the following keywords: "Hygienic and Sanitary Housing Requirements of dwellings", also together with the words "Building codes" (BCs), "Minimum Requirements", "Health Requirements".

We dedicated much interest to "The European Portal for Energy Efficiency in Buildings" (http: //www.buildup.eu), as well as on the government websites of the different member states, where the related BCs were found.

The study was initially designed to compare only the BCs available in English on the official websites. Considering the limited number of documents translated into this language, documents in French, German, Spanish and Portuguese were also included in the research, in order to include some of the most populated EU countries and a significant fraction of population.

The analysis of the BCs aimed at identifying which are the sanitary requirements of dwellings proposed in different countries, and how these are declined within the norms, in order to be able to compare them with the contents of Italian legislation and collect suggestions for its update. In order to allow the comparison, only the aspects of the BCs concerning the scale of the building were examined, excluding the analysis of the urban parameters.

In particular, the comparison concerned all the requirements specified by the Health Ministerial Decree dated July 5th, 1975, and some other parameters not specifically included in the Ministerial Decree but in other regulations, and relevant to indoor wellbeing [26, 43].

Results

The study led to the selection of documents pertaining to 9 EU countries (Table 1), representative of at least 3 of the macro-geo-political subdivisions of the European continent.

In particular, the countries were the following:

- Sweden, United Kingdom (UK), Denmark – (Northern Europe);
- The Netherlands, France, Germany – (Central Europe);
- Portugal, Spain, Italy – (Southern Europe).

Overall, these countries are populated by over 360 million people, which equals to about half (48.9%) of the resident population in EU member States by 2018.

The national references used for the comparative analysis are reported in Table 1. It should be pointed out that in some countries the regulations on urban planning and the BCs are separate documents (United Kingdom, Italy, Sweden), while in other countries both are included in a single standard (Denmark, France, Germany, the Netherlands) [44]. Furthermore, some countries (e.g., The Netherlands, Portugal) introduced a unique tool that refers to or contains references to all the specific areas of the construction field (e.g.: dimensional, energy, acoustic, etc.), while others, including Italy, have a plurality of documents, regulations and laws related to each sector.

In general, the formulation of technical requirements for buildings in BCs follows three main approaches [45]: *functional*, which defines the main objectives for each requirement, but does indicate neither the method to determine them, nor the levels of performance to be achieved and/or references to specific solutions; *performance*, which defines the level of performance that the requirement must satisfy in quantitative terms, and the method to measure it; *prescriptive*, which imposes values for each requirement and the specific or detailed design solutions.

All the described approaches were found in the building codes included in this study. In particular, the UK regulation is functional;

Table 1 - Population, population density, and list of Documents examined. Source: https://www.populationpyramid.net/it/italia/2019

Countries	Population (*updated to 2019*)	Density pers/km^2 (*updated to 2019*)	Documents
United Kingdom	67,530,161	277.21	The Building Regulations 2010 Building (Amendment) Regulations 2016 Building Act 1984, as amended by the Deregulation Act 2015
Sweden	10,036,391	22.43	Boverket´s building regulations 2016 Boverket´s building regulations 2018
Denmark	5,771,876	134.47	Executive order on building regulations 2018 (BR18)
Germany	83,517,046	233.69	Hessische Bauordnung (HBO) 2012 (Model Building Code)
France	65,129,730	118.61	Décret n°2002-120 (Version consolidée au 11 juin 2017) Code de la Costruction et de l'Habitation (Building and housing code)
The Netherlands	17,097,123	411.58	Building Decree [Bouwbesluit] 2012
Italy	60,550,092	200.94	Ministerial Decree, July 5th, 1975 (and M.I. 1896 for the relevant parts still in force)
Spain	46,736,782	92.38	Royal Decree 314/2006 Código Técnico de la Edificatión (CTE) Documento Basico SU - Segurided de utilizacion y accesibilidad 2018 Documento Basico HS - Salubridad 2017 Documento Basico HE - Ahorro de EnergÍa 2013 DECRETO 141/2012, de 30 de octubre, por el que se regulan las condiciones mínimas de habitabilidad de las viviendas y la cédula de Habitabilidad. Cataluña
Portugal	10,226,178	110.88	Regulamento Geral das Edificações Urbanas (RGEU) 2009-01-01

Denmark, Germany, the Netherlands, Spain and Sweden BCs are predominantly performance-based, with some prescriptive requirements; France, Italy and Portugal have prescriptive building codes, flanked by more recent, often sector-specific, performance-type technical standards.

Table 2 compares the requirements prescribed in Italy by the DM issued in 1975 with those included in the BCs of the other countries, with the addition of indoor chemical pollution and ionizing radiations, as they are of particular health relevance. The analysis shows a substantial variability among regulations. In particular, in the United Kingdom BC the only health parameters that are regulated include the supply of drinking water, sanitary facilities, mechanical ventilation and sound insulation, while in other countries such as Sweden, Denmark, the Netherlands and Spain there are further regulated issues.

Table 3 compares the dimensions of dwellings and living spaces provided for by the BCs in the examined countries. A first distinction concerns the definition of living space. In Italy, the Circular Letter of the Ministry of Public Works dated July 23rd,

Table 2 – Comparison between the parameters of the Ministerial Decree, July 5th, 1975 and the contents of the Building Codes of 8 European countries

	Italy	United Kingdom	Sweden	Denmark	Germany	France	The Netherlands	Spain	Portugal
Minimum height	+	-	+	+	+	+	+	+	+
Living space	+	-	+	+	-	+	+	+	+
Studio apartment area	+	-	+	-	-	-	-	+	+
Heating systems	+	-	+	+	+	+	+	+	-
Natural lighting	+	-	+	+	+	+	+	+	+
Mechanical ventilation	+	+	+	+	+	+	+	+	+
Sanitary facilities	+	+	-	+	+	+	+	+	+
Sound insulation	+	+	+	+	+	+	+	+	-
Drinking water supply	+	+	+	+	+	+	+	+	+
Indoor chemical pollution	-	-	+	+	-	-	+	+	-
Ionizing radiations	-	-	+	+	-	-	+	-	-

1960, n.1820 defines it as "total surface of useful rooms" (useful rooms) [46], while, in most other BCs, these surfaces are generically defined as shared spaces destined to "stay", and this makes a direct comparison between the standards quite difficult.

Only in Italy and France the dimensional standards of living spaces are measured in square metres per inhabitant: in Italy, the minimum requirement is 14 m^2 for the first 4 occupants, and is reduced to 10 m^2 for each additional inhabitant; similar standards are indicated by French legislation, in which, however, the living space includes the entire net area of the accommodation. In Spain, the minimum dimensions for living spaces in new construction are 20 m^2, and include the living spaces, the living room and the kitchen. The Netherlands legislation sets a minimum standard for living spaces of

Table 3 - Size of housing or living space in housing

Countries	Living space (m^2)	Habitable volume (m^3)	Studio apartment area (m^2)
Italy	14	-	28
United Kingdom	-	-	-
Sweden	-	-	-
Denmark	-	-	-
Germany	-	-	-
France	14	33	-
The Netherlands	18	-	-
Spain	20	-	20
Portugal	-	-	35

Table 4 - Dimension of habitable rooms in different countries

Countries	Surfaces per inhabitant			Side length
	Living room (m^2)	Bathroom (m^2)	Single bedroom (m^2)	Room (m)
Italy	14	-	9	-
United Kingdom	-	-	-	-
Sweden	-	-	-	-
Denmark	-	-	-	-
Germany	-	-	-	-
France	-	-	9	-
The Netherlands	11	2.2	-	3
Spain	-	-	6	-
Portugal	10	3.5	10.5	2.1

18 m^2 for new buildings or, in any case, at least greater than 55% of the surface of the entire house, differentiating the serviced spaces (living room, kitchen, bedroom) from the serving spaces (bathrooms, hallways, circulation spaces, technical spaces).

Sweden indicates performance standards for house dimensions, but does not numerically specify them [40], while United Kingdom, Denmark, Germany (Hesse) do not indicate direct nor indirect requirements for the dimension of dwellings in their BCs.

With regards to studio-apartments, the Italian and Spanish legislations refer to net surfaces, while the Portuguese to gross surfaces. The Ministerial Decree of July 5th, 1975 provides dimensional indications for housing (studio apartment) in proportion to the number of inhabitants (at least 28 m^2 for one inhabitant, at least 38 m^2 for 2); the same criterion is the basis of the Portuguese regulation, which identifies the minimum accommodation for one person as 35 m^2 (gross). The Decree 141/2012 enforced in the Catalan Region (Spain) indicates a minimum surface for pre-existing houses of 20 m^2.

Almost all the BCs included in this study define minimum surface requirements for habitable rooms, with the exception of United Kingdom, Germany - Hesse (eliminated since 2002) and Denmark (Tab. 4). However, we observed a wide variability in the dimensions of each room among the standards [47].

The Swedish BC provides performance requirements and recommends referring to a national standard, which gives functional indications, but does not specify the minimum dimensions of habitable rooms.

In the Italian standard, the single bedroom must have a minimum size of 9 m^2 (14 m^2 if double) and a living room of 14 m^2, while in Portugal the first bedroom must be at least 10.5 m^2 and can accommodate up to two people (9 m^2 for the second double room, and 6 m^2 for the single room) and the living room must be at least 10 m^2 (if needed, plus 6 m^2 for the kitchen).

The Netherlands has the highest standard for a living space (11 m^2, with a width ≥3 m) for new constructions, while for existing buildings the minimum size of the room is 7.5 m^2 (with a width ≥2.40 m). The French legislation has similar values, as the minimum area of the room is 9 m^2, and in any case not less than 7 m^2.

The BC of Spain [48] too reports different standards for pre-existing and new buildings: in this latter, the minimum prescribed dimensions are 6 m^2, while the pre-existing construction rooms must have a usable surface of not less than 5 m^2.

Table 5 – Minimum room heights in the standards examined

Countries	Minimum height (m)		
	Main rooms	Utility rooms	Garrets and basements
Italy	2.70	2.40	
United Kingdom	-		
Sweden	2.40		2.30
Denmark	-		
Germany	2.40		2.20
France	2.20		
The Netherlands	2.60	2.20	
Spain	2.50	2.20	
Portugal	2.70	2.20	

For all the examined countries, with the exception of the United Kingdom, regulations impose the number of bathrooms (at least one bathroom is required) and the sanitary facilities they must be equipped with. The Netherlands indicate minimum dimensions for toilets (0.90 x 1.20 m) and bathrooms (1.6 m^2 with a width of at least 0.8 m); if combined, the minimum area of the room must be 2.20 m^2 with a side of at least 0.90 m. Portugal also indicates 3.50 m^2 as the minimum area for bathrooms.

As reported in Tab. 5, the selected countries regulate the rooms' minimum height, with prescription that apply to all residential buildings (existing and new) [43]. Also in this case there is a variability between the standards, but it appears to be less marked with comparison to surface prescriptions. In Italy and Portugal, the minimum height of the ceiling is intended to be 2.70 m, while in the other nations the minimum heights of the rooms vary from 2.60 m in the Netherlands to 2.14 m in the United Kingdom (this limit has been abolished in national codes, but is fixed in local regulations).

Most of the standards considered in this study, that are to be applied to both pre-existing and new constructions, include dimensional values for windows for the purpose of natural lighting (Tab. 6), with some differences between countries. In many cases, the window surface is weighted to

Table 6 – Natural lighting of the rooms in the standards examined

Countries	Natural light (window area in% of the room surface)	
	Value(%)	Minimum value to be guaranteed (m^2)
Italy	1/8	-
United Kingdom	-	-
Sweden	10%	-
Denmark	10%	-
Germany	1/8	-
France	-	-
The Netherlands	10%	0.5 m^2
Spain	10%	-
Portugal	1/10	1.8 m^2

that of the floor (Italy, Sweden, Denmark, the Netherlands, Spain, Germany). Only in the Netherlands the minimum window size varies between new and existing buildings (10% of the floor area for existing buildings, and a minimum of 0.5 m^2 for new constructions).

In Italy, the Ministerial Decree dated July 5th,1975 also prescribes the amount of natural light to be provided in the building, to be assessed by estimating the average daylight factor, for which a value of not less than 2% of external natural light is expected.

With respect to air quality, all the national BCs included in the study, in accordance with national technical regulations and specific laws of the sector, provide indications on natural and mechanical ventilation. In the Netherlands, the BC sets specific standards for the ventilation rate; in the United Kingdom and Germany adequate ventilation (both natural and mechanical) is required in all rooms, however without indicating specific standards. Also, in Spain, the DB-HS [49] prescribes that dwellings must be equipped with a general ventilation system, which can be hybrid or mechanical, and specifies the general characteristics (e.g., air circulation from dry to wet rooms, technical features on air supply flow, etc.).

In Portugal, the Regulation sets the obligation of ventilation in all rooms, and forced ventilation for toilets, while in Sweden the BC provides general indications on the ventilation systems, referring to the technical norms for specific standards.

In Italy, the provisions included in the Ministerial Decree dated July 5th, 1975 are descriptive; in fact, the art. 6 imposes that "When the characteristics of the dwelling determines conditions that do not allow for natural ventilation, centralized mechanical ventilation must be used, introducing air that is appropriately collected and with suitable hygienic requirements". In order to determine the specific standards for ventilation rate and the characteristics of ventilation systems, reference has to be to different standards. In all countries, the regulations prescribe adequate ventilation in bathrooms and kitchens.

The selected European regulations do not set limits for airborne concentrations of indoor pollutants, referring to different legislation and/or technical regulations [6]. With respect to pollutants deriving from building material, in the examined countries two approaches are identified: some BCs refer to other specific documentation (e.g., Spain), while others integrate part of the technical and/or sectoral legislation (e.g.: Denmark, the Netherlands). There is no explicit mention of air changes in any BC.

Noise pollution, in both its indoor and outdoor components, represents a topic of growing interest in Europe [50]. Statistics show that around 18% of the EU population reports issues linked to noise from their neighbours or road traffic. Italy is just below the European average, with a percentage of 16.2% [50]. In Italy, the Ministerial Decree dated July 5th, 1975 deals with noise pollution with a purely functional approach, while the subject is treated more in-depth by a subsequent technical regulation and sector law. The same approach is observed in French legislation. On the contrary, in other countries, a deeper analysis of the topic is already reported in the BC, and further integrated with performance specifications, and there is often a reference to the technical regulation of the sector for further details (as in Sweden).

Heating systems related to both rooms and sanitary water, as well as their maintenance, are extremely important in order to guarantee healthy living conditions [43, 40]. Heating systems are included in all the examined regulations, but they are not listed as mandatory in Portugal and the United Kingdom. In Italy, article 4 of the Ministerial Decree dated July 5th, 1975 requires an indoor air temperature ranging between

18° and 20°; in the remaining countries, the BCs and sector regulations set standards for indoor air temperatures based on climatic conditions. In Germany, for example, an environmental heating system must be installed to reach 18-20°C indoors, in France a temperature ranging between 18-19°C must be guaranteed inside the dwellings, as in Sweden (18° C), while in Spain the RITE (*Reglamento de Instalaciones Térmica en los Edificios*) sets indoor air temperature in the range of 21-23 °C; in the Netherlands, the temperature values of the indoor environments are to be 20-25°C.

The requirement to install water heating systems is indicated in all the examined codes in the countries included in the study; in Italy, the MD of 1975 makes no reference to water heating systems. The selected regulations provide indications and criteria for the maintenance of the systems, such as periodic controls of the heating systems. In the United Kingdom, the law requires owners to carry out annual checks, in Germany biennial, in Italy the maintenance and control of the plants is regulated by the Presidential Decree 74/2013, which refers to specific technical instructions.

Discussion

A criticality of this study is linked to the fact that, as hygienic-sanitary provisions are often included within the most disparate normative acts, at both national and local levels, the description of the contents of the foreign BCs could be not completely exhaustive. Likewise, the differences in health care authorities, but also the political and administrative structure of the different states, contributed to the complexity of this research.

Furthermore, the retrieval of almost all the documentation in the original language excluded some European countries that were equally interesting from the point of view of their political and environmental characteristics. However, the present research compares regulatory measures that concern about half of the European population, representing an effort in the direction of understanding the fundamental bases of determination of the sanitary requirements of civil dwellings in different countries, and how these requirements are expressed and applied.

A first consideration concerns the approach adopted in structuring the different BCs, which reflects very different principles and priorities, sometimes far from the strict sanitary requirements [51]. In general, the BC formulation is mainly based on performance requirements, often in combination with more functional or prescriptive requirements [44]. An important example of this approach concerns the dimensional aspect (heights, distances, habitable surfaces) which is still subjected to a prescriptive approach in a large number of countries. On this specific topic, in the examined documents we observed different formulations: we move from a more market-oriented logic (e.g., United Kingdom), in which minimum dimensions are not defined, to a purely prescriptive one (Italy), to a more functionality-oriented (the Netherlands) [47].

In particular, the Decree of the Italian Ministry of Health dated July 5th, 1975, unlike other examined documents, considers precautionary dimensional parameters for the inhabitants, in order to protect also the most fragile social classes, especially in terms of living spaces which, however, must be adjusted to the new functional requirements, also for the purpose of the psychological well-being of the inhabitants [3, 52, 53]. In this regard, it is worth remembering what has been described in some studies [54-56], from which it emerges that the dimensions of the dwelling represent a determining factor in the choice of where to live and how, as often residents complain of insufficient space to carry out the basic activities of their

daily life. This is particularly true for some sections of the population (e.g.: the elderly) for whom living spaces can cause serious movement and accessibility limitations [26], or for those socio-economically disadvantaged [4].

Moreover, considering the prescribed heights, the above-mentioned MD appears to be mainly oriented to avoid overcrowding [52, 53] rather than guaranteeing adequate air volumes per person. It is possible to vary the environmental volume according to air changes within certain limits with respect to the current regulatory standards; however, it is necessary to keep in mind the wellbeing needs of people, which do not allow a high number of air changes, if this involves an excessive air speed [52]. In assessing ventilation, the volume of the entire house must be taken into account, and not just that of the single room, the type of windows and the presence of other air evacuation systems. Technological innovations in the field of construction and materials, which could allow an additional share of natural ventilation, should not be overlooked. Therefore, the "prescriptive" approach to ventilation could be replaced by a "performance" approach, if there were rules on the concentration limits for each pollutant in indoor air, now defined by the WHO guidelines [57]. In this regard, it is necessary to underline that the MD does not deal with the problems connected to indoor pollution and radiation protection, which are instead considered by *ad hoc* norms in different countries [6]. As it is known, improving indoor air quality is a determining factor for physical well-being, especially for the prevention of asthma, bronchitis and allergies [5]. Different pollutants may be present in indoor air, deriving from building materials or from activities performed indoors, with negative effects on the health of the inhabitants [5, 6]. For some years the EU Commission has intended to adopt some new proposals that combine the improvement of energy efficiency with greater healthiness of buildings [58]. At a community level, several countries defined and adopted reference values or guide values for pollutants of greater interest, in terms of quantity (mass of pollutant) and quality (environmental persistence, toxicity, olfactory threshold, etc.) and in Italy several exceptions were made [6, 37, 56]. Therefore, from the comparison with the regulations of different countries, the Ministerial Decree dated July 5th, 1975 is also limited on this specific point.

Also, the wording of some fundamental themes included in all the BCs considered in the study such as, for example, heating systems, mechanical ventilation, is not updated with respect to technological-scientific innovation consolidated over the last few years.

Conclusions

The comparative analysis we carried out made it possible to identify convergences and divergences in the standards analysed for the different European countries. Italy has recently adopted a single document at national level, namely the "Building Regulation-Type" (*Regolamento Edilizio-Tipo* or *RET*) [59], which is comparable to some foreign BCs; this document, that has already been implemented in many Italian regions, if compared to the previos situation, has been enriched with sanitary contents. For this reason, in this study, we compared the BCs of the selected countries with the DM July 5th, 1975, which to date is still the main national reference regarding the usability of living spaces. This is in order to draw inspiration for identifying suitable evaluation criteria and methods to allow their enhancement also in the RET, in an updated and integrated format for the missing parts.

In this regard, it is necessary to highlight that in this paper the attention was mainly

directed towards comparing the elements of building mostly implicated in the definition of its habitability, leaving out aspects linked to the context, on a neighbourhood scale, which instead heavily condition its internal quality and real usability. These aspects are now considered central by the WHO [26] and are punctually considered in the examined BCs. This refers in particular to factors such as the quality of the site, the relationships between the building and the context, the presence and quality of green areas surrounding the building, as well as all the measures that allow reducing the impacts of the building on the environment, to protect against environmental pollution, to manage the building in an integrated manner, for the purposes of its maintenance [60].

Riassunto

Requisiti igienico-sanitari delle abitazioni in Europa: un'analisi compartiva di nove paesi

Negli ultimi anni le condizioni abitative hanno ricevuto un crescente interesse da parte della comunità scientifica e della sanità pubblica, tanto da essere oggi considerate uno dei principali determinanti ambientali e sociali di salute della popolazione. Lo scopo dello studio è analizzare e confrontare le normative vigenti in materia di requisiti igienico-sanitari delle civili abitazioni in diversi paesi dell'Unione Europea (Svezia, Regno Unito, Danimarca, Paesi Bassi, Francia, Germania, Portogallo, Spagna) con i contenuti del DM Sanità 5 luglio 1975 italiano. I Building Codes sono stati tutti reperiti su Internet in siti web istituzionali. Per il confronto sono stati presi in esame unicamente gli aspetti dei BC riguardanti la scala dell'edificio; il confronto ha riguardato tutti i requisiti previsti dal DM Sanità 5 luglio 1975 ed alcuni altri parametri (es. inquinamento chimico indoor, radiazioni ionizzanti, radiazioni non ionizzanti) non previsti nel DM, trattati nelle altre norme, e rilevanti ai fini del benessere indoor degli occupanti.

Gli autori osservano un'ampia variabilità nei contenuti e nella formulazione dei requisiti igienico-sanitari tra i diversi Building Code, soprattutto per quanto riguarda i dati dimensionali e alcune tematiche fondamentali (es. impianti di riscaldamento, la ventilazione meccanica) la cui trattazione spesso non risulta aggiornata rispetto all'innovazione tecnologico-scientifica consolidatasi nel corso degli ultimi anni.

Si osserva, inoltre, un approccio diversificato nei diversi BC: da una logica orientata al mercato (ad esempio, Regno Unito), a una prescrittiva (Italia), a una orientata alla funzionalità (Paesi Bassi). L'analisi comparativa effettuata ha permesso di individuare convergenze e divergenze nelle norme analizzate per i diversi stati europei. Per quanto la normativa italiana in merito di agibilità dei locali d'abitazione, infine, considerando le tendenze sanitarie, sociali, ambientali ed economiche, molti standard contenuti nel DM 5.07.1975 dovrebbero essere rivisti e aggiornati.

Funding: CCM 2015 Project "Identification of best practices and health performance objectives, in terms of sustainability and eco-compatibility in the buildings' construction and renovation actions, aimed to draft the further building hygiene codes". Codex CUP: B86D15001870001

References

1. Kreiger J, Higgins DL. Housing and health: time again for public health action. Am J Pub Health 2002; **92**(5): 758-68. doi: 10.2105/ajph.92.5.758.
2. Jacobs DE, Kelly T, Sobolewski J. Linking public health, housing, and indoor environmental policy: successes and challenges at local and federal agencies in the United States. Environ Health Perspect 2007; **115**(6): 976-82. doi: 10.1289/ehp.8990.
3. Goromosov MS. Bases physiologiques des normes d'hygiene applicables au logement. Geneva: OMS, 1968.
4. D'Alessandro D, Raffo M. Adeguare le risposte ai nuovi problemi dell'abitare in una società che cambia. Ann Ig 2011; **23**(3): 267-74.
5. De Martino A. Linee-guida per la tutela e la promozione della salute negli ambienti confinati. Ig Sanita Pubbl 2001; **57**(4): 407-14.
6. Settimo G, D'Alessandro D. [European community guidelines and standards in indoor air quality: what proposals for Italy]. Italian. Epidemiol Prev 2014; **38**(6 Suppl 2): 36-41.
7. Thomson H, Thomas S, Sellstrom E, Petticrew M. The health impacts of housing improvement: A systematic review of intervention studies from 1887 to 2007. Am J Public Health 2009; **99** (Suppl 3): S681-92. doi: 10.2105/AJPH.2008.143909.

8. Lowry S. Indoor air Quality. BMJ 1989; **299**(6712): 1388-90. doi: 10.1136/bmj.299.6712.1388.
9. Lowry S. Noise, space and light. BMJ 1989; **299**(6713): 1439-42. doi: 10.1136/bmj.299.6713.1439.
10. Mendell MJ, Mirer AG, Cheung K, Tong M, Douwes J. Respiratory and allergic health effects of dampness, mold, and dampness-related agents: a review of the epidemiologic evidence. Environ Health Perspect 2011; **119**(6): 748-56. doi: 10.1289/ehp.1002410.
11. Jaakkola JJ, Hwang BF, Jaakkola MS. Home dampness and molds as determinants of allergic rhinitis in childhood: a 6-year, population-based cohort study. Am J Epidemiol 2010; **172**(4): 451-9. doi: 10.1093/aje/kwq110.
12. Etheridge D. A perspective on fifty years of natural ventilation research. Building and Environment 2015(91): 51-60. https://doi.org/10.1016/j.buildenv.2015.02.033.
13. Hemsath TL, Walburn A, Jameton A, Gulsvig MA. A review of possible health concerns associated with zero net energy homes. J Hous and the Built Environ 2012; **27**: 389-400. https://doi.org/10.1007/s10901-011-9260-7.
14. Hood E. Dwelling disparities: how poor housing leads to poor health. Environ Health Perspect 2005; **113**(5): A310-7. doi: 10.1289/ehp.113-a310.
15. Capasso L, Faggioli A, Rebecchi A, et al. Aspetti igienico-sanitari in ambito urbanistico: conflittualità nelle norme urbanistiche nazionali e locali in tema di sanità pubblica [Hygienic and sanitary aspects in urban planning: contradiction in national and local urban legislation regarding public health]. Epidemiol Prev 2018; **42**(1): 60-4. doi: 10.19191/EP18.1.P060.016.
16. Capasso L, Capolongo S, Faggioli A, Petronio MG, D'Alessandro D. Living in a Semi-basement in the Era of Floods. Italian Laws Cause Inequalities in Health Protection. Ann Ig 2015; **27**(2): 502-4. doi: 10.7416/ai.2015.2038.
17. World Health Organization (WHO). Closing the gap in a generation. Health equity through action on the social determinants of health. Geneva: WHO, 2008.
18. Whitehead M, Dahlgren G. What can be done about inequalities in health? Lancet 1991; **338**(8774): 1059-63. doi: 10.1016/0140-6736-(91)91911-d.
19. Marmot M, Allen J, Bell R, Bloomer E, Goldblatt P. WHO European review of social determinants of health and the health divide. Lancet 2012; **380**(9846): 1011-29. doi: 10.1016/S0140-6736-(12)61228-8.
20. Martin WJ 2nd, Glass RI, Balbus JM, Collins FS. A major environmental cause of death. Science 2011; **334**(6053):180-1. doi: 10.1126/science.1213088.
21. Capasso L, Capolongo S, Faggioli A, Petronio MG, D'Alessandro D. Do Italian housing regulations and policies protect poor people's health? Ann Ig 2015; **27**(4): 688-9. doi: 10.7416/ai.2015.2060.
22. Centers for Disease Control and Prevention and U.S. Department of Housing and Urban Development. Healthy housing reference manual. Atlanta: US Department of Health and Human Services, 2006.
23. Lowry S. Housing. BMJ 1991; **303**(6806): 838-40. doi: 10.1136/bmj.303.6806.838.
24. Brasche S, Bischof W. Daily time spent indoors in German homes--baseline data for the assessment of indoor exposure of German occupants. Int J Hyg Environ Health 2005; **208**(4): 247-53. doi: 10.1016/j.ijheh.2005.03.003.
25. Eurostat. Living condition in Europe. European Union, 2018.
26. Bonnefoy X. Inadequate housing and health: an overview. Int J Environ Pollut 2007; **30**(3-4): 411-29.
27. Signorelli C, Capolongo S, Buffoli M, et al. Italian Society of Hygiene (SItI) guidelines of the for healthy, safe and sustainable housing. Epidemiol Prev 2016; **40**(3-4): 265-70.
28. Rosen G. A history of public health. Baltimore and London: The John Hopkins University Press, 1993.
29. D'Alessandro D, Appolloni L, Capasso L. Public health and urban planning: a powerful alliance to be enhanced in Italy. Ann Ig 2017; **29**(5): 453-63. doi: 10.7416/ai.2017.2177.
30. Belikova VK. Bactericidal property of solar radiations penetrating closed premises. Gig Sanit 1957; **22**(11): 8-15.
31. Ichihashi M, Ueda M, Budiyanto A, et al. UV-induced skin damage. Toxicology 2003; **189** (1-2): 21-39. doi: 10.1016/s0300-483x(03)00150-1.
32. Rosenthal NE, Sack DA, Carpenter CJ, Parry BL, Mendelson WB, Wehr TA. Antidepressant effects of lighting seasonal affective disorder. Am J Psychiatry 1985; **142**(2): 163-9. doi: 10.1176/ajp.142.2.163.
33. Lowry S. Temperature and humidity. BMJ.

1989; **299**(6711): 1326-8. doi: 10.1136/bmj.299.6711.1326.
34. Capasso L, Basti A, Savino A, Flacco ME, Manzoli L, D'Alessandro D. Semi-basements used as dwellings: hygienic considerations and analysis of the regulations. Ann Ig 2014; **26**(1): 3-9. doi: 10.7416/ai.2014.1955.
35. Braubach M. Key challenges of housing and health from WHO perspective. Int J Public Health 2011; **56**(6): 579-80. doi: 10.1007/s00038-011-0296-y.
36. Perdue WC, Stone LA, Gostin LO. The built environment and its relationship to the public's health: the legal framework. Am J Public Health 2003; **93**(9): 1390-4. doi: 10.2105/ajph.93.9.1390.
37. Capasso L, Gaeta M, Appolloni L, D'Alessandro D. Health Inequalities and Inadequate Housing: the Case of Exceptions to Hygienic Requirements for Dwellings in Italy. Ann Ig 2017; **29**(4): 323-31. doi: 10.7416/ai.2017.2159.
38. Popov VI, D'Alessandro D, Gaeta M, Capasso L. Lighting requirements of dwellings: a comparison between Russian Federation and Italy. Ann Ig 2016; **28**(3): 202-7. doi: 10.7416/ai.2016.2098.
39. Sheridan L, Visscher HJ, Meijer F. Building regulations in Europe Part I - A comparison of the systems of building control in eight European countries. Delft: Delft University Press, 2002.
40. Sheridan L, Visscher HJ, Meijer F. Building regulations in Europe Part II - A comparison of technical requirements in eight European countries.Delft: Delft University Press, 2003.
41. Thomson H, Petticrew M, Morrison D. Health effects of housing improvement: systematic review of intervention studies. BMJ 2007; **323**(7306): 187-90. doi: 10.1136/bmj.323.7306.187.
42. Popov VI, Capasso L, Klepikov OV, Appolloni L, D'Alessandro D. Hygienic Requirements of Urban Living Environment in the Russian Federation and in Italy: a comparison. Ann Ig 2018; **30**(5): 421-30. doi: 10.7416/ai.2018.2242.
43. WHO Europe. Housing and health regulations in Europe. Final Report 2006. Supported by the convention between The French Ministry of Health and World Health Organization, Regional Office for Europe, with the support of the Municipality of Forlì, Italy and the Region Emilia-Romagna, Italy.
44. Daldy AF. Scope of building legislation BRS Current Paper CP33/69.1969. BRS (Ministry of Public Building and Works).
45. Pedro JB, Meijer FM, Visscher HJ. Technical Building Regulations in EU Countries: A Comparison of their Organization and Formulation. CIB World Congress 2010 "Building a Better World". Salford, UK, May 10-13, 2010. ISBN 978-1-905732-90-6.
46. Circolare Ministero dei Lavori Pubblici 23 Luglio 1960, n. 1820. Definizioni in materia di Costruzioni edilizie.
47. Rigolon A. European housing standards. 2009. In: Gelsomino L, Marinoni O, eds. European Housing Concepts 1990-2010. Editrice Compositori, 2009: 47-51.
48. DECRETO 141/2012, de 30 de octubre, por el que se regulan las condiciones mínimas de habitabilidad de las viviendas y la cédula de habitabilida.
49. Documento Basico HS. Salubridad. Junio 2017.
50. Quotidiano Sanità 2018. Available on: http://www.quotidianosanita.it/studi-e-analisi/articolo.php?articolo_id=57595 [Last accessed: 2020, Oct 9].
51. Gola M, Signorelli C, Buffoli M, Rebecchi A, Capolongo S. Local health rules and building regulations: a survey on local hygiene and building regulation in Italian municipalities. Ann Ist Super Sanita 2017; **53**(3): 223-30. doi: 10.4415/ANN_17_03_08.
52. D'Alessandro D, Faggioli A. Nuovi criteri per la casa sana e proposte per una linea guida della Società Italiana di Igiene. Ann Ig 2013; **25**(3 Suppl 1): 127-31.
53. Capolongo S, Rebecchi A, Buffoli M, et al. COVID-19 and cities: from urban health strategies to the pandemic challenge. A decalogue of public health opportunities. Acta Biomed 2020; **91**(2): 13-22. doi: 10.23750/abm.v91i2.9615.
54. Commission for Architecture and the Built Environment (CABE). Space in new home: what residents tink. Royal Institute of British Architects, 2009.
55. Reynolds L. Full house? How overcrowded housing affects families. Shelter, October 2005. ISBN 1 903595 51 7.
56. D'Alessandro D, Gola M, Appolloni L, et al. COVID-19 and living spaces challenge. Well-being and public health recommendations for a healthy, safe and sustainable housing- Acta Biomed 2020; **91**(9-S): 61-75. doi: 10.23750/abm.v91i9-S.10115.
57. WHO Europe. WHO Guidelines for indoor

air quality. Selected pollutants. Bonn: WHO, 2010.
58. Commissione Europea. Communication from The Commission to the European Parliament and the Council. Energy efficiency and its contribution to energy security and the 2030 Framework for climate and energy policy. COM (2014) 520 final. Brussels, 23.7.2014.
59 Intesa 20 Ottobre 2016. Adozione Regolamento Edilizio-Tipo RET. Intesa, ai sensi dell'articolo 8, comma 6, della legge 5 giugno 2003, n. 131, tra il Governo, le Regioni e i Comuni concernente l'adozione del regolamento edilizio-tipo di cui all'articolo 4, comma 1 – sexies del DPR 6 giugno 2001, n. 380. G.U. n. 268 del 16.11.2016.
60. D'Alessandro D, Capolongo S. Ambiente costruito e salute. Linee d'indirizzo di igiene e sicurezza in ambito residenziale. Milano: Franco Angeli, 2015.

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