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From building regulations and local health rules to the new local building codes: a national survey in Italy on the prescriptive and performance requirements for a new performance approach

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Abstract

Background. *World Health Organization has highlighted the need to strengthen the relationship between health and built environment factors, such as inappropriate housing conditions. Building Regulations and Local Health Rules provide safety and building hygiene in construction practices. Currently the Italian Government is giving rise to a Building Regulation Type and the paper aims to verify the present contents of recent innovative Local Health Rules and Building Regulations of several Italian municipalities for supporting the performance approach of the future Building Regulations including hygienic issues.*
Methods. *The analysis examines both Building Regulations and Local Health Rules of a sample of about 550 cities, analysing some specific fields of interest: urban field, outdoor issues, housing features, housing restrictions, and qualitative aspects.*
Results. *The analysis focuses on some specific aspects defining the general data reported in Building Regulations and Local Health Rules, in particular around surfaces, heights, lighting and aeration ratio, basements and semi-basements, gas radon, building greenery, etc.*
Conclusions. *The investigation permitted to have a wide vision on the present State of the Art in order to highlight some innovative aspects and design approaches of Building Regulations and Local Health Rules. New perspectives in the new regulations should have a performance approach, starting also from the recent SARS-CoV-2 pandemic.*

Introduction

The World Health Organization (WHO) and several international institutions highlight the need to implement several actions and strategies aimed at promoting appropriate relationships between health and environment to prevent non-communicable diseases (1-2). The Italian Constitution declares "*human health is a guaranteed right*". For this reason, at different scales, several regulations aimed at health promotion and

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protection, in particular, environmental and building hygiene regulations are promoted by the Ministry of Health through the National Health Service (NHS).

Urban planning acts are among the most relevant primary prevention tool against environmental risks because they allow evaluating the factors that can affect physical and mental health and social integration of the population (3-5).

Among the main factors, inadequate attention to housing conditions is considered one of the most harmful, and it is fundamental to promote best practices for building construction and renovation (6-8).

In particular, as some authors highlighted (9-10), the issue is crucial especially in relation to current disparities across the population's living conditions, according to the geo-localization, economic condition, education level, and ethnicity. In fact, these differences, which affect the general health status of the population, are mainly related to some undergoing social changes (economic crisis, immigration growth, population aging, climate changes, etc.) (11-12).

Nowadays, in Italy, the municipal regulation issue is controversial, because, especially in the small and medium-sized urban centers, that are entitled by law to draft and adopt those regulations, but nowadays they have not enough human and economic resources to keep functional and updated these documents (13).

The regulatory autonomy of municipalities is broad, especially in the field of interest not regulated by the National Government and Regional ones; this has allowed the municipal administrations to define different contents and information independently (14). In addition to this scenario, health and hygiene are less considered, and often different interests prevail, such as the economic ones; also in preventive evaluations of urban plans, such as i.e. Strategic Environmental Assessment (SEA), health aspects are not totally investigated.

State of the Art

Local Health Rules (LHRs) and Building Regulations (BRs) act at the urban and building scales. They were introduced with the National Planning Law No. 1150/1942 and Ministerial Instruction of 1896 (15). These regulations have an organic structure and report technical standards for building construction, such as technical, healthcare, safety, aesthetics, livability issues, and in some cases, environmental sustainability of buildings.

In Italy currently, there is a general legislative disorder due to the contents and standards that can be found in both BRs and LHRs, but sometimes also in technical standards of Municipal Development Plans (MDPs), especially when there is any inconsistency between the contents of BRs and LHRs (9). In this case, for example, the BR of Milan states that in case of conflict, health and hygiene issues contained in the BR prevail over those in the LHRs.

The inhomogeneity of construction procedures among the municipalities is due to the high number of existing municipalities (as much as 7,798 in 2017), different technical regulations, the strong dissimilarity on the contents and definitions. For these reasons, after 2014, in order to reduce the discrepancies and trying to unify all the regulations, the adoption of a national BR-Type was approved. It is a regulatory standard for all Italian municipalities, with which every single municipality can regulate the construction activities on its territory, suggesting the design and construction requirements that best conform to local needs. In general, this is a homogenization of the definitions and it does not provide indications on requirements or performances.

The BR-Type collects all the rules and requirements to define the construction activities for buildings and urban areas: health and safety features and requirements; accessibility criteria; incentives related to the redevelopment of buildings, energy-saving and renewable energy sources, green building approach, etc.

Nowadays, it has also been stated the agreement among the Government, the regions and local authorities to adopt the BR-Type. Currently, several regions have approved its application and a list of the 42 uniform definitions has been officially approved.

However, there is a lack of information and content related to building hygiene. For this reason, the current analysis becomes useful for decision-making and other possible actions that the Government can implement in BR-Type for all the municipalities, as Legislative Decree No. 90/2014 states, and that could be extended also to LHRs' issues (7).

Methods

Despite the increasing exploitation of local administrations, the contents of the BRs continue to be controversial, especially in medium and small towns. In this scenario, the building hygiene issue tends to be not considered mandatory by several administrations, which consider that all the legislative tasks are absolved at the National and regional level, while the operative issues by Local Health Authorities (LHAs).

A survey conducted by Signorelli et al. (16) and subsequently updated by Gola et al. (17) investigated the implementation of some issues that the current legislation delegates to the municipalities. To obtain a statistically significant sample of the Italian reality, the municipalities were divided into four categories:

• type A: consisting of the ten metropolitan cities with the highest number of inhabitants;

• type B: made up of municipalities with over 50,000 inhabitants not included in type A;

• type C: made up of municipalities with a population between 5,000 and 50,000 inhabitants;

• type D: consisting of municipalities with less than 5,000 inhabitants.

For each Region, 30 municipalities were subdivided into 10 of type A and B, 10 of type C, and 10 of type D. The selection was not carried out at random, but the authors decided to consider the municipalities with at least a BR or LHR updated (17), to be able to draw up a survey on supporting documents for performance considerations, investigated by the working group.

It is important to underline that the recent update of the regulation does not simultaneously imply the updating of all the contents of the document even only the modification of a minimum part involves updating the document while remaining obsolete in most contents. In the case of a lack of LHRs, the authors proceeded by checking whether the BR was approved by the LHA (17). If BR was not approved, the authors have analyzed the LHRs.

The survey has foreseen as study cases all those municipalities that have both BRs and LHRs updated from 2007 to 2017 to verify the update status (17). Out of 550 cases studied, only 24 municipalities met the following requirements:

• type A and B - Milan, Turin, Verona, Prato, Ravenna, Siracusa, Pescara, Bergamo, Novara, Arezzo, Savona, Agrigento, Olbia, Cuneo, and Pordenone;

• type C - Bastia Umbria, Ariano Irpino, Giulianova, Mirano, Cecina, Bra, Conegliano, Corsico, and Mantua.

The choice of the analysis criteria was made starting from the study by Gola et al. (17). Among several topics, the analysis investigated:

• **urban field**:

– distances between buildings (i.e. minimum distances to be guaranteed among buildings' facades);

– heights of buildings (i.e. maximum height that a building should guarantee);

- **outdoor issues**:
  - courtyards (i.e. minimum dimensions to be guaranteed, and percentage of green area to guarantee);
  - garbage room (i.e. minimum dimensions, its localization, specific requirements to be guaranteed);
- **housing features**:
  - surfaces (i.e. minimum dimensions to be guaranteed, rooms' features, etc.);
  - heights (i.e. minimum heights to be guaranteed in housing environments);
  - lighting and aeration ratio (i.e. value of the ratio, daylight factor, dimensions of the living rooms, solar exposure, etc.);
- **housing restrictions**:
  - living environments in basement and semi-basement (i.e. the conditions for living spaces, minimum characteristics, etc.);
  - mezzanine (i.e. minimum dimensions to be guaranteed, minimum heights, etc.);
- **qualitative aspects**:
  - thermo-hygrometric comfort (i.e. requirements to be guaranteed);
  - acoustic insulation (i.e. requirements to be guaranteed, strategies for adequate acoustic performances, etc.);
  - energetic efficiency (i.e. requirements to be guaranteed, strategies for high energetic performances, etc.);
  - building greenery (i.e. green roof strategies, design strategies, etc.);
  - gas radon (i.e. height of crawl spaces, design strategies for regular ventilation, etc.).

Results and Discussion

Starting from a broad analysis of the BRs and LHRs, the research project permitted to focus only on some specific issues emerged from the analysis, synthesized in Table 1.

Urban field

Distances between buildings

From the analysis carried out, there are several requirements related to minimum distances to be guaranteed between buildings with a range among 3 m (BR Bologna, 2003; BR Sarre, 2015) and 10 m (BR Naples, 1999; BR Palermo, 2004; BR Reggello, 2014), with a median value equal to 5 m. Similar

Table 1 - Percentages of the BRs and LHRs that argue each topic, sub divided into the three geographical locations.

Data analysis	Northern Italy		Central Italy		Southern Italy and islands	
	BRs	LHRs	BRs	LHRs	BRs	LHRs
Distances between buildings	33%	0%	46%	0%	55%	0%
Heights of buildings	4%	11%	6%	0%	5%	22%
Courtyards	25%	41%	53%	54%	55%	33%
Garbage room	29%	23%	13%	0%	20%	0%
Surfaces	66%	70%	73%	72%	85%	33%
Heights	66%	64%	732%	72%	85%	77%
Lighting and aeration ratio	50%	55%	76%	68%	75%	38%
Living environments in basements	54%	76%	73%	72%	90%	40%
Mezzanine	50%	47%	60%	36%	45%	11%
Thermo-hygrometric comfort	12%	30%	6%	27%	20%	22%
Acoustic insulation	41%	41%	73%	54%	70%	33%
Energetic efficiency	50%	11%	53%	0%	35%	0%
Building greenery	46%	0%	40%	0%	25%	0%
Gas radon	8%	11%	0%	0%	10%	0%

distances, for different municipalities, are requested for windowed fronts, in which 10 m is the most common value.

In other regulations, instead, the authors observe that the minimum distance is strongly associated with the width of roads (18), as Table 2 shows. Differently, in other cases, the buildings must have different minimum distances in relation to the buildings located at the property border: 7 m from buildings, 8 m from green areas, 10 from villas or townhouses (BR Rome, 1997); otherwise the BR of Biella (2007) defines that the minimum detachment varies in relation to the proximity to historic center (8 m) or in another context (10 m).

If the distances are not defined by regulations, designers must refer to the technical standards by the urban instruments of the municipality (19).

In general, the analysis shows that the criterion considers also: possibility of natural lighting and ventilation, external views, adequate levels of privacy, personal and collective security, space-time orientation for the perceptual identification of entrances (20-22).

Heights of buildings

In relation to this issue, very different requirements are provided, lacking of a common approach. The widespread reference is related to width of the streets, as Table 3 highlights. Other regulations are more specific, for example: the BR of Naples (1999) defines that the maximum height of the façades cannot exceed the average height of the urban area; in the LHRs of Ancona (1959) the height of houses should not surpass the width of half of the road's width or public space on which it faces; in the LHRs of Perugia (1943) the maximum elevation cannot exceed three times the width of the street; etc. Differently, in some LHRs, it is defined the maximum number of floors in relation to the width of the road (i.e. LHRs of Turin, 2012).

If the information are not defined by regulations, even for very tall buildings (i.e.

Table 2 - Specific requirements related to distances between buildings.

Width of the road	< 7 m	increased by	5 m	BR of Ancona (2012), BR of Macerata (2015), BR of Offida (2011), BR of Augusta (2006), BR of Norcia (2007)
	7 - 15 m		7.5 m	
	> 15 m		10 m	
	< 10 m		5 m	BR of Nardò (2001)
	10 – 15 m		7.5 m	
	> 15 m		10 m	

Table 3 - Specific requirements related to heights of building.

for streets of width (W) equal to	< 12.4 m	the height is – at least	1.5 W	BR of Turin (2016) and LHRs of Turin (2012)
	> 12.4 m		14.5 + W/3	
	> 18 m		1.1 (14.5 + W/3)	
	> 35 m		35 m	
	2 - 3 m		< 3 W	LHRs of Venice (1981)
	3 – 3.9 m		1.5 + 2.5 W	
	3.91 – 4.5 m		11.25 m	
	> 4.5 m		2.5 W	

skyscrapers), designers must refer to the technical standards by the urban instruments of the local municipality (23).

Outdoor issues

Courtyards

From the analysis carried out, the dimensions for courtyards vary from 1/8 of the surface (BRs Palermo, 2004) to 1/3 (BR Bari, 2012; LHRs Aosta, 1934), with a median value equal to 1/5. In some cases it is not defined a ratio and/or a percentage, but a minimum width that must be guaranteed with a range between 3 m (BR Ancona, 2012; BR Macerata, 2015; BR Offida, 2011) and 15 m (BR Augusta, 2006), in which 10 m is the most widespread dimension.

Other BRs, however, set other requirements much more specific, for example: for the BR of Frosinone (2003) the surface of courtyards - for at least 50% - must be a garden; in BR of Florence (2015) the minimum area must be 60 sqm for new buildings and 40 sqm for existing ones; in BR of Venice (2015), the courtyards must have a surface not less than 40% of the sum of the walls' surfaces.

Garbage room

The presence of garbage room, nowadays, is a very important requirement in buildings, although for several decades many buildings have been built with a specific external room for garbage. The most innovative regulation was the first BR of Milan, at the end of XIX century that imposed the introduction of garbage room.

The analysis observes that the garbage room is not widespread. Only in some regulations it should be *localized* outside the building, and it should have a height of about 2 – 2.4 m, in some cases the surface varies from 2 to 5 sqm (BR Milan, 2016), with specific requirements regarding door design, typically in metal, with dimensions of 1 x 2 m.

In other cases, instead, the BRs mention the presence of a *garbage room* without any specified detail.

Housing features

Living environments

The Ministerial Decree No. 190/1975 defined a series of rules relating to the size of housing in relation to the number of inhabitants, the minimum size of studio flat for one or more people, and the minimum size of some living environments. Starting from the existing norms, the analysis performed highlighted several dimensional values (24-25).

The **studio flat**, including a bathroom, can have minimum dimensions ranging from 25 sqm (BR Sacile, 2014) to 45 sqm (BR Naples, 1999). Although most of the case studies suggest 28 sqm, the research team has also found different values, for example 30 sqm for BR of Bari (2012) and LHRs of Milan (1999), 32 sqm for BR of Bisaccia (2003), 38 sqm for BR of San Donà di Piave (2009), 40 sqm for BR of Sarre (2015), 42 sqm for BR of Arco (2013).

Differently, the **two-room apartment** shows values between 35 sqm (BR Sacile, 2014) and 45 sqm (BR Bisaccia, 2003), while the most widespread value is 38 sqm.

As the Ministerial Decree No. 190/1975 stated, the **single room** typically sizes 9 sqm but in BR of Sacile (2014), Milan (2016), Matino (1976), and Trento (2014) the value is 8 sqm. In some LHRs, the cubic meter of air persists, with values equal to 24 cubic meters (refer to LHRs Lecco, 1989; Agrate Brianza, 1996; San Donà di Piave, 2002).

The **double room** sizes 14 sqm, but in BR of Sacile (2014) and Milan (2016) the value is 12 sqm. In some LHRs the cubic meter of air is equal to 38 cubic meters (refer to LHRs Lecco, 1989; Agrate Brianza, 1996).

The **living room** varies from 9 to 14 sqm, and the last one is the most common. Since the real estate trends introduce **living**

room with integrated kitchen area, only some regulations suggest to increase the surface with variable ranges from 15.5 sqm (BR Potenza, 2009), 16 sqm (BR Sarteano, 2012), 17 sqm (BR Milan, 2012; BR Agrate Brianza, 2012; 18 sqm (BR Matino, 1976; BR Arco, 201; BR San Donà di Piave, 2009); 18,5 sqm (BR Masi Torello, 2009).

Differently for **kitchen,** there are different values for large kitchens and uninhabitable ones, with ranges between 4 and 9 sqm and/ or 13.5 and 24 cubic meters.

Finally, the areas for **bathrooms** (in some regulations different values are provided for the main and secondary bathroom), where WC, sink, bidet and shower are requested, show very variable values from 1 sqm (BR Lecco, 1972) to 5 sqm (BR Arco, 2013). With regard to the bathrooms, with respect to technological and engineering system development, there is still the persistence of the anteroom or disengagement as a filter between living spaces, with the exception of bedrooms.

Although dimensional features are reported, there is, however, a notable lack in the regulations concerning a minimum side to be guaranteed for furnishing and comfortable environments (26), in the light of many design experiences that over the years have given rise to uninhabitable environments from the psycho-physical point of view (27). Only the BR of the city of Milan imposes the minimum side of 1.2 m in the bathrooms, and the LHRs of Masi Torello (2009) for the cooking area with a width not less than 1.5 m.

This datum, although it can be considered a constraint in the design process, would guarantee, however, a coherent dimensioning of the spaces, even with a reduced area of 8 sqm, as outlined in Figure 1.

Internal heights

The Ministerial Decree No. 190/1975 defined the minimum internal height of living rooms equal to 2.70 m, reduced to 2.40 m for corridors, bathrooms, toilets and storage rooms; for mountain municipalities not less than 1000 m above sea level, the minimum height of living rooms is reduced to 2.55 m.

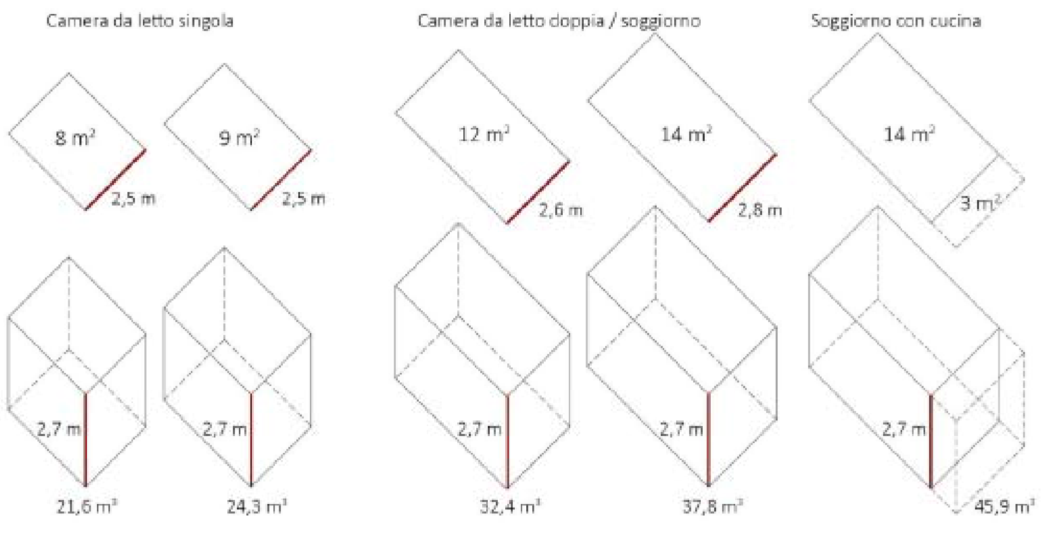

Figure 1 - Surfaces and heights for the design of single and double bedrooms, and living rooms and integrated kitchen area.

Nowadays, different regulations define different heights in relation to different typologies of environments:

• the main living spaces (living room, kitchen, bedrooms, rooms with continuous presence of people) with a range between 2.4 m (BR Quart, 2012; BR Sacile, 2014; BR Buttrio, 1994) and 2.8 m (BR L'Aquila, 1972; BR Giulianova, 2011; BR Lecco, 1972), with peaks of 3/3.5 m in - not updated - LHRs of Reggio Calabria (1939), L'Aquila (1948), Rome (1932), Ancona (1959), Bari (1938), Perugia (1943), and San Donà di Piave (2002);

• secondary rooms (such as toilet, study room, hobby room) with a range between 2.2 m (BR Trento, 2014; LHRs San Donà di Piave, 2002) and 2.8 m (BR L'Aquila, 1972; BR Giulianova, 2011), observing that the widespread value is 2.4 m;

• service rooms (hallway, closet, corridor, other spaces without continuous presence of people) from 2.1 m to 2.8 m, with a median value of 2.4 m.

Finally, for municipalities with specific altitudes, it is recognized that at the height of 700/900/1000/1100 meters above sea level the height of the main living spaces can be decreased respectively to 2.4 m for BR of Trento (2014), BR of Arco (2013) and BR of Quart (2012), or 2.55 m for BR of Baunei (2001) and BR of Norcia (2007). Instead, for all those regulations without any specific internal heights, the designers should refer directly to the present regional and national norms, while in the case of habitable attics each municipality gives different references.

Lighting and aeration ratio

It is well-known the opportunity to guarantee optimal aeration and lighting ratio equal to 1/8 of the room surface. From the analysis carried out, this value is rather widespread, but it was observed that LHRs of Palermo (2013) requires 1/6 of the floor area, and in several regulations (i.e. LHRs Turin, 2012; LHRs Milan, 1999; BR Milan, 2016–only for ventilation; etc.) the value is reduced instead to 1/10 (28).

The latter one (1/10) is also recognized in several BRs for secondary rooms with values equal to 1/10 for Catanzaro (2005), 1/12 for L'Aquila (1972), Giulianova (2011), San Nicola la Strada (1984), San Donà di Piave (2009), and 1/14 for Campobasso (1976).

Regarding the altitude, several BRs state that ratios may vary (i.e. BR of Arco, 2013):

• in areas of the valley floor (up to 500 m) the illumination and aeration surface must be not less than 1/8 of the room surface;

• in mid-mountain areas (at altitudes of more than 500 and less than 900 m above sea level), the lighting and aeration ratio should be not less than 1/10 of the room area;

• in mountain areas (over 900 m above sea level), the illumination and aeration surface must not be less than 1/12 of the floor surface (BR of Arco, 2013).

Finally, in addition, in several BRs it emerges that the lighting ratio must be related to the depth of the room, as Table 4 reports.

Regarding the daylight factor, in several regulations, the value should be not less than 2%, only the BR of Bari (2012) imposes a value of 3%.

In relation to the technological solutions of the last decades, the BRs do not show any suggestion in relation to external and internal darkening systems and user's discomfort (29).

In general, the values are treated indistinctly by the location of the room (in the basement, ground floor, upper floors, etc. and by solar exposure). Although many BRs do not allow living spaces in the basements, in some BRs aeration ratio is considered with the following values: 1/7 for LHRs of Bari (1938), 1/8 for BRs of Rome (1997), Catenanuova (1995) and Trento (2014), and the LHRs of San Nicola la Strada (2004), Genoa (1992), Biella (2003), San Donà di Piave (2002), and 1/10 for the LHRs of Ancona (1959) and Aosta (1934).

In conclusion, in relation to the minimum aeration and lighting ratio, the bathrooms have different requirements. The analysis, in fact, highlights that window opening can have a minimum area between 0.2 and 0.9 sqm, divided into:

• 0.2 sqm for the BR of Campobasso (1976);

• 0.4 sqm for the BRs of L'Aquila (1972), Giulianova (2011), San Nicola la Strada (1984), Florence (2015);

• 0.5 sqm for the BRs of Milan (2016), Agrate Brianza (2012), Bari (2012), Trento (2014), etc. and the LHRs of Milan (1999), Agrate Brianza (1996), San Donà di Piave (2002), etc.;

• 0.6 sqm for the BRs of Reggello (2014), Arco (2013), San Donà di Piave (2009), etc. and the LHRs of Catanzaro (2010), Nardò (2001), etc.;

• 0.75 sqm for the BR of Genoa (2010);

• 0.8 sqm for the BR of Augusta (2006);

• 0.9 sqm for the BR of Lecco (1972).

According to UNI EN 12792(2005), air changes can be done naturally or artificially (30). In the latter case, for blind bathrooms, there are two different approaches:

• continuous ejection with values between 5 and 6 vol/h for several BRs and LHRs;

• mechanical suction with values between 10 and 15 vol/h for for several BRs and LHRs.

Living environments in basements and semi-basements

It is known that the Ministerial Decree No. 190/1975 historically abolished living spaces in basements (29, 31). From the analysis carried out, however, it emerges that basement or semi-basement rooms can be used as dwellings in some municipalities (24, 32): in particular, the basements are recognized by the BRs of Genoa (2010), Ortisei (2013) and Bastia Umbra (2011); differently BRs of Potenza (2009), Maratea (2012), Baunei (2011), Florence (2015), etc. permit to have living spaces only in semi-basements. Differently LHRs and BRs act at the urban and building scales. They were introduced with the National Planning Law No. 1150/1942 and Ministerial Instructions of 1896. These regulations have an organic structure and report technical standards for building construction, such as technical, healthcare, safety, aesthetics, livability issues, and in some cases, environmental sustainability of buildings.

Table 4 - Specific requirements related to lighting ratio.

When the depth of each room results	up to 2.5 times the height	the minimum lighting ratio must be	1/10	BR of Frosinone (2003), BR of Milan (2016)
	up to 3.5 times the height		1/8	
	up to 2.5 times the height		1/8	BR of Bari (2012)
	over 2.5 times the height		1/6	
	up to 2.5 times the height		1/8	BR of Nardò (2001)
	Over 2.5 times the height		1/12	
	up to 2.5 times the height		1/8	BR of Sarteano (2012)
	up to 3.5 times the height		> 1/4	
	over 3.5 times the height		not allowed	
	up to 4.5 times the height		1/8	BR of Lecco (1972)
	over 4.5 times the height		1/6	

Currently, the healthiness of basement environments has recently been the subject of a wide debate among the general population, the political spheres and the Italian scientific community, after the approval of the Regional Law of Lombardy "Recovery of living spaces in existing basements" (31, 33).

In some cases, the habitability is guaranteed with different features, for example:

- rooms in semi-basements can be used only for kitchen, and secondary rooms for the dwellings with - at least - 1/4 of their height outside the ground floor (BR Matino, 1976) or with a maximum height of 1 m below the ground level (LHRs Naples, 2001);
- living rooms in semi-basement should be placed above at least 1 m from the maximum groundwater level (BR Potenza, 2009).

As the LHRs of Aosta (1934) mentioned, the Mayor, after the opinion of the Health Officer, has the faculty to authorize the habitability of living spaces in basements.

Among the references, there are also some specific data related to heights, whose values vary between 2.2 m (BR Sacile, 2014) and 3.5 m (BR Campobasso, 1976), with median values between 2.7 and 3 m. Other references, instead, impose a minimum height above ground level to be guaranteed, with values between 1 m (BR Lecco, 1972; BR Turin, 2016; LHRs Reggio Calabria, 1939) and 1,6 m (BR Potenza, 2009; BR Augusta, 2006; BR Bastia Umbra, 2011; etc.).

In other cases, instead, specific requirements are given as reported in Table 5.

Mezzanines

It is known that the mezzanines are allowed in living spaces. Several regulations define the maximum surface that can occupy the loft area, with a variable range between 1/4 of the surface (BR Nardò, 2001; BR Augusta, 2006) and 2/3 (BR Cigliano, 2009; BR Florence, 2015; BR Quart, 2012; BR Venice, 2015; BR Aosta, 2015), with a median value of 1/2 of the surface.

The construction of the mezzanine is closely related to the height of the environment. The regulations impose minimum heights:

- underlying area with a range of 1.8 and 2.7 m, with a median average value of 2.2 m;
- overlying area with a variable range between 1.9 and 2.5 m, with a median equal to 2.2 m.

In some cases, depending on the general height available, it is possible to have variable dimensions, as Table 6 reports.

Table 5 - Specific requirements related to living environments in basements and semi-basements.

The height of the room can be equal to	2.4 m	with height above ground level	not less than 1/3	BR of Alghero (2014)
	2.7 m			LHRs of San Nicola la Strada (2004), LHRs of Biella (2003)
	2.8 m		at least 3/4	BR of San Donà di Piave (2002)
	3 m		not less than 1/3	LHRs of Ancona (1959)
	3 m		at least 1/2	LHRs of Bari (1938), LHRs of Perugia (1943), BR of Rome (1997)
	3 m		at least 1/4	BR of Matino (1976)

Table 6 - Specific requirements related to mezzanines.

If the height of the mezzanine is around	2.3 – 2.7 m	the maximum surface is	1/2	BR of Milan (2016)
	> 2.7 m		3/4	
	2 – 2.7 m		3/5	BR of Palermo (2004)
	> 2.7 m		2/5	
	< 2.4 m		1/3	BR of Isernia (2007), BR of Reggello (2014)
	> 2.4 m		1/2	

Qualitative aspects

It is well-known that (indoor) environmental comfort affects the psycho-physical wellbeing of users in indoors (34, 35). It is strongly related to the sum of several parameters that should be appropriately guaranteed through a careful building design process and management (36).

Considering the relationship between humans and the built (indoor) environment, among the main requirements, the analysis highlights several emerging issues in particular regarding the thermo-hygrometric and acoustic comfort, energetic issue, and building greenery.

Thermo-hygrometric comfort

The UNI-EN-15251 defined the thermo-hygrometric comfort' requirements for buildings. The reference to the law is also referred in the regulations.

From the analysis, it is clever that both in BRs and LHRs emphasize the importance of adequate thermo-hygrometric comfort in living spaces, due to the construction and technological best practices in building design.

Acoustic insulation

The Italian Decree of the President of the Council of Ministers 5th December 1997 defined the passive acoustic performances' requirements for buildings. The reference to the law is also referred in the regulations.

From the analysis, it is clever that LHRs emphasize the importance of correct sound insulation in living spaces (37).

Energy efficiency

In Italy the legislation that defines the energy performances of a building is the Energy Certification, replaced by the Energy Performance Certificate with the Decree 63 (2013). The certificate attributes a class of energy performance in relation of summer and winter consumptions (38). These requirements of the certifications are also recalled in BRs.

Building greenery

Despite the importance of the topic, especially in new projects, among the LHRs analyzed it is not argued and it is cited only in 40% of the BRs taken into consideration, defining the need for the integration and the importance of green spaces in order to improve building quality and mental health of user, as reported by D'Alessandro et al. (39) and Wood et al. (40).

In particular, the BRs refer to the use of green roofs and green walls, as adequate systems for the mitigation and better environmental integration of residential and non-residential building systems. As the scientific literature highlights (41), the benefits deriving from these technological systems are numerous and they are related both to the urban context and to the behavior of the building. The trees and green, in fact, through to their own vegetative processes, improve the air quality, absorbing carbon dioxide and retaining the fine powders (42-43), interact with the external microclimate, assimilating energy and limiting overheating facades and they have an important psychological effect due to the pleasant presence of green surfaces even in unexpected areas of the city (44-45). In addition, the system is also a natural noise barrier and constitutes an efficient acoustic and thermal insulation, contributing to the containment of energy consumption of the building on which it is installed (2). The cost of these strategies is naturally higher than the traditional ones, but allows savings in maintenance and energy consumption (46).

Only in some of the analyzed regulations emerge more specific features: for example the BR of Milan (2016) suggests that the surface of the green roof must extend for - at least 50% - of the roof surface. In other cases, qualitative performance aspects are provided, as in BR of Trieste (2004) states, which, in order to improve the microclimate in the surrounding of the buildings and reduce both the visual impact and the outflow of rainwater to the sewage system, are allowed and suggested, within the limits of technical conditions, green flat roofs and hanging gardens.

It is therefore important to analyze the different design strategies: it is possible to provide green roof with extensive and non-practicable green, with a slightly thick of 5-15 cm (for example, BR of Bergamo –2014- requires a minimum thickness of 15 cm), or with intensive and practicable one with a thickness of 50/60 cm. In any case, it is necessary to ensure a minimum slope between 1 and 5% and the insertion of anti-root barriers.

Gas radon

The analysis shows that only 5% mentions the ionizing radiation in indoors with particular emphasis on Radon gas. As it is well-known, this gas is cancerous and without any ventilation system the health effects of users can be very impactful (47-48).

Although only some regulations refer to gas radon, several documents require the introduction of crawl spaces in the foundations. From the analysis, the heights vary from 0.2 m to 0.6 m, and the value is strongly affected by Radon concentrations due to the typology of soil and geographical location (33). In specific, some building codes do not provide only a value but also some requirements and/or design features: for example in the building codes of Bisaccia in 2003, crawl space is not permitted in new buildings, and the ground floor should be positioned at a height of 15 cm - at least - above the street level for guaranteeing an adequate ventilation, waterproofing and insulation system; differently the Building Codes of Milan in 2016 suggest that basements must have a crawl space with a minimum height of 50 cm, but the height can be reduced to 25 cm as long as the ventilation is increased proportionally up to 1/50 with horizontal grids or 1/100 with vertical ones.

Conclusions

Currently several regions have approved the application of the national BRs, but there is not any BRs with the new configuration. The main goal is to give rise to updated regulations with similar contents and structures, and common terms and definitions.

The analysis permitted to have a wide vision on the present State of the Art in order to highlight some innovative aspects and design approaches on some specific topics. In this paper, the data analysis reports only some peculiar aspects of the many criteria investigated in the research work.

The hygienic requirements of buildings ought to have a clear and unambiguous expression at local level, surpassing the dualism between BR and LHRs and refer to a territory wider than the municipal one, as already happened in some realities (29).

The new vision should give rise to regulations without dimensional requirements, but with performances to be reached and guaranteed for healthy living environments (49-52), as Petronio et al. (53) have already promoted with bio-sustainable building, aiming that such scientific papers may support the decision-making to consider or even add hygienic criteria in the BR-Type.

In addition the recent SARS- CoV-2 pandemic has highlighted the need to rethink the living spaces, to their flexibility during the time, and the users' comfort, and both physical and mental health promotion (54-58). In fact, new BRs and LHRs should address the designers to guarantee high performances of dwellings as D'Alessandro et al. (59) state.

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Riassunto

Dai regolamenti edilizi e regolamento locali d'igiene ai nuovi regolamenti: un'indagine sul territorio italiano sui requisiti prescrittivi e prestazionale per un nuovo approccio progettuale

Premessa. L'Organizzazione Mondiale della Sanità ha evidenziato la necessità di rafforzare il rapporto tra salute e fattori relativi all'ambiente costruito, come le condizioni abitative inadeguate. I regolamenti edilizi ed i Regolamenti Locali d'Igiene forniscono indicazioni sulla sicurezza e l'igiene degli edifici in fase di costruzione. Attualmente il governo italiano sta attuando il regolamento edilizio tipo; l'articolo mira a verificare i contenuti attuali dei recenti innovativi Regolamenti Edilizi e Regolamenti Locali d'Igiene di diversi comuni italiani per supportare l'approccio prestazionale del prossimo Regolamento Edilizio Tipo, comprensivo degli aspetti igienico-sanitari.

Metodo. L'analisi esamina sia i Regolamenti edilizi che i Regolamenti Locali d'Igiene su un campione di circa 550 città, analizzando alcuni ambiti di interesse specifici: aspetti urbani, tematiche dell'outdoor, caratteristiche delle abitazioni, requisiti minimi e aspetti qualitativi.

Risultati. L'analisi si concentra solo su alcuni aspetti specifici che definiscono i dati generali riportati nei Regolamenti Edilizi e nei Regolamenti Locali d'Igiene, in particolare riguardo a superfici, altezze, rapporti aero-illuminanti scantinati e seminterrati, gas radon, verde, ecc.

Conclusioni. L'indagine ha permesso di dare un'ampia visione dell'attuale stato dell'arte al fine di evidenziare alcuni aspetti innovativi e approcci progettuali dei Regolamenti edilizi e dei Regolamenti Locali d'Igiene. Le nuove prospettive nei nuovi regolamenti dovrebbero avere sempre più un approccio prestazionale, anche a partire dalla recente pandemia SARS-CoV-2.

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