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**Dipartimento Universitario Clinico di Scienze**  
**mediche, chirurgiche e della salute**



Laurea Magistrale in Medicina e Chirurgia

**Cost-effectiveness of the italian screening protocol  
for international adoptees**

Ottobre 2018

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Anno Accademico 2017/2018

*“Every single minute matters,  
every single child matters,  
every single childhood matters.”*

- Kailash Satyarthi, Indian children's rights activist

## *Abstract (Italian)*

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# *Abstract*

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# *Acknowledgements*

To my friends *I Cazzilli*: Fede, Lorenz, Grismina and Ste, for always being worthy of being the family I chose for myself and for looking out for me day after day.

To Emme, for showing me what true compassion is and inspiring me to be a better version of myself everyday.

To Carol, the closest tea-brewing sister I could hope for. I'm truly proud of you.

To my Mom, for teaching me, among another thousand things, her own personal special way of calling somewhere "*home*".

To my Dad, for always trying to be the man he ought to be.

To the rest of my strange, enlarged family, for always supporting me in every possible way.

To Luca, my tireless desk-mate and friend, who never called himself out of an all-nighter and who always speaks a word of kindness or dedication in times of need.

To Valentina, who helped me stand in times when I couldn't stand for myself.

To Matteo, an amazing companion in this journey through pediatrics, data sets and enthusiastic English-vocabulary show off.

To dott. Monasta, for making sense of numbers that didn't seem to have any.

To prof. Barbi and prof. Ventura, for remembering me that medicine can be how i dreamed it.

And lastly, to myself, for always believing that, even when your heart's lost all its hope, after dawn there will be sunshine.

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# Abbreviations

<b>HIV</b>	<b>H</b> uman <b>I</b> mmunodeficiency <b>V</b> irus
<b>STI</b>	<b>S</b> exually <b>T</b> ransmitted <b>I</b> nfection
<b>MCV</b>	<b>M</b> ean <b>C</b> orpuscular <b>V</b> alue
<b>VBA</b>	<b>V</b> isual <b>B</b> asic for <b>A</b> pplications

# Chapter 1

## Introduction

Children's health has historically always been a sensitive and concerning matter for human kind. We can find reason for this in our universal instinctive draw towards the protection and care for our offspring, and in how children can be struck by some of the most devastating and life-wrecking diseases. Sometimes, these are the phenotypical expression of genetical marks, scarred onto and into these kids. Despite the origin, the color of the skin or the culture the child bears in his lineage, human beings feel the need to raise and safeguard them from all harms, on a physical, emotional and spiritual level. This is one of the strongest biological calls to action.

Thus, pediatrics must care and remember that children's health and well-being must be guarded across political borders, across poverty, across starvation. This thesis, and the paper it's so deeply bound to, set themselves to renew this vow.

### 1.1 Intercountry and international adoptees

International adoptees are children with special needs: a vulnerable pediatric population with a chronic condition that requires access to a wide variety of healthcare services (as defined by [7] and [8]); they are recognized as a group of children requiring medical attention (see [11]). Compared to 19% of the general population,

approximately 39% of adopted children require special healthcare attention (as extensively explained in [1]). They are of school age, part of a sibling group, members of historically oppressed racial or ethnic groups, or they have considerable physical, emotional, or developmental need: all potential elements of vulnerability endangering the child's healthy upbringing. This is not a limited problem: annually more than 30.000 kids are adopted across countries, and, in the United States, of all 136.000 national adoptees in 2008, almost 25% come from foreign countries; U.S. families adopted 22.884 children in 2004, mostly from China (which accounts for 33% alone), Ehtiopia, Russia and South Korea (see [1]), 8.868 more in 2012 and 4.714 in 2017 (see [3]). It's estimated that more than 125.000 children have been adopted in the United States alone since 1986 (source can be found in [11]). Further data on annual U.S. international adoptions and their social and financial costs can be found at [4]. More in depth medical issues, will be discussed in Section 1.2.

Although personal experiences obviously vary, most children placed for international adoption have some history of poverty and social hardship in their home countries, and approximately 65% are adopted from orphanage or institutional settings (as stated in [11]). As explained in [1], the effects of institutionalization and other early life stresses impact all areas of early growth and development. As a result, many children require specialized support and understanding to overcome such impacts and to reach their full potential.

Moreover, as in [2], internationally adopted children may withstand a number of juridical and social impairments even after adoption. No generalization can be made on this matter though, since laws and policies greatly differing among countries. They may be stripped of their name (a.e. in Cape Verde, Argentina and Turkey), have no right to inheritance (a.e. in Republic of Moldova and France), see the termination of the relationship with birth parents and relatives (a.e. in Japan, Albania and Togolese Republic), loose their citizenship and not acquire a new one (a.e. Hungary and New Zealand), or even bear limitations on marriage in their adult life (a.e. in Argentina and France). These boundaries are to be considered associated to the emotional and psychological stress of new surroundings, new affections, new habits, and even new climatic environments (which can be clinically relevant, as explained in

1.3.2.2).

All these elements account for some of the factors that contribute to the hardships an adoptee must endure throughout his life and call for a strong action from pediatric physicians and social services employees, as possible support figures which may change these kids' lives forever.

### **1.1.1 Levels and trends in intercountry adoption worldwide**

International adoption is increasingly considered a measure of last resort worldwide, if the child's birth family or community are unable or unwilling to care for him anymore (see [1]), justifying the downward trend on international adoptions across the globe.

The United Nations Population Division estimates that about 40.000 intercountry adoptions took place each year around 2005, accounting for 15% of the total number of adoptions (see [2]). As shown in Table 1.1 and 1.2, the involved countries, both for destination and origin, are relatively few.

Destination countries are led by the United States with over 127.000 total adoptions in 2001. Even though it accounts for nearly half of all adoptions, only 15% of American families decide to take care of a child coming from outside the US. France and Spain (both with a significant annual adoptions, ranging from 4,000 to 5,000 adoptions per year), instead, embrace 80-90% of all adoptions from foreign lands, although they have far less total adoptions per year. Almost all countries adopt primarily from China and Russia, confirming data shown in 1.2. The median percentage of international adoptions in all examined countries is 64 a remarkable value and effort in helping children from developing countries.

The Italian adoption status will be discussed in 1.1.2.

Rank	Receiving country <sup>1</sup>	Number	Percentage	Main country of origin
1	United States of America	19.056	15	China
2	France	3.995	90	Haiti
3	Spain	3.951	82	Russia
<b>4</b>	<b>Italy</b>	<b>2.177</b>	<b>68</b>	<b>Russia</b>
5	Germany	1.919	34	Russia
6	Canada	1.875	46	China
7	Sweden	1.093	65	China
8	Netherlands	1.069	78	China
9	Denmark	688	55	China
10	Norway	664	76	China
11	Switzerland	558	79	Colombia
Median		370	64	

TABLE 1.1: Countries of destination with the largest number of intercountry adoption.

*Source: United Nations Population Division report (see [2])*

Countries of origin are better balanced throughout the globe, with China leading the chart, followed by Russia, Guatemala and Ukraine. Guatemala and Ethiopia stand out for the exceptional percentage of international adoptions among all, with 97% and 93% respectively. As clearly shown in Table 1.2, the United States are the preferred destination country for most of the listed nations.

All of the countries listed below struggle with some sort of social hardship: political instability, poverty, inequality, starvation, ethnic or civil wars, complex and violent pasts. Eyes can't closed and mouths shut, when it so obviously portrayed that children are the ones paying from these adulthood failures. They must run, be saved, separated, deported in order to be granted one single chance, one single hope.

Rank	Receiving country <sup>1</sup>	Number	Percentage	Main receiving country
1	China	8.644	19	United States
2	Russia	5.777	25	United States
3	Guatemala	3.726	97	United States
4	Ukraine	2.672	35	United States
5	Korea	2.258	58	United States
6	Vietnam	1.419	49	United States
7	India	1.098	36	United States
8	Bulgaria	1.010	44	<b>Italy</b>
9	Kazakhstan	948	26	United States
10	Colombia	846	60	France
11	Ethiopia	810	93	France
Median		50	34	

TABLE 1.2: Countries of origin with the largest number of intercountry adoption.

*Source: United Nations Population Division report (see [2])*

In Table 1.3 the leading countries both of origin and of destination have been divided for the most oriented towards international adoptions out of all national adoptions per year. Belgium, France and Luxembourg lead the receiving side; Ethiopia, Guatemala, Mali and Thailand the origin side, instead, with over 90%.

<sup>1</sup>Only countries with more than 500 adoptees per year were included. For the complete table, please see the referenced source.



60 to 74%	75 to 89%	90% or more	60 to 74%	75 to 89%	90% or more
Andorra	Cyprus	Belgium	Colombia	Georgia	Ethiopia
Australia	Liechtenstein	France	Latvia	Haiti	Guatemala
Israel	Netherlands	Luxembourg	Grenada		Mali
Italy	Norway		Honduras		Thailand
Singapore	Spain		Niger		
Sweden	Switzerland		Togo		
(A) Receiving Countries			(B) Countries of origin		

TABLE 1.3: Countries with the highest percentual international adoptions.  
*Source: United Nations Population Division report (see [2])*

As explained in [5] and [6], in recent years, international adoption rates have been dropping. As shown in the Figure 1.1, the United States’ foreign adoptions have dramatically fallen from 18.856 children per year in 2000 to 2.681 in 2016: more than 75% has been cut. This isn’t a U.S. isolated problem, though; world-wide international adoption rates are on the fall in the past two decades, due to policy changes in the countries of origin. In recent decades South Korea, Romania, Guatemala, China, Kazakhstan and Russia, all former leaders in foreign adoption (see [2] and Table 1.2), have banned or cut back on international custody transfers. For example, the number of Guatemalan children adopted by foreign parents dropped from 4100 in 2008 to a stunning 58 in 2010 ( in Figure 1.1), after the country drastically curtailed the practice and China decreased its foreign adoptions by 86% in a decade ( in Figure 1.1).

As policies change, it’s often stated that it’s in “the best interest of the child”, a point usually supported by a strong media-driven high-profile infantile abuse or neglect case. These incidents are rare: only a 0.03% rate. In Russia, on the other hand, the rate of child abuse is about 25 times higher. Such statistics call into question whether the child’s best interest is really why countries have been canceling international adoption. Authors have found that political pressures and international

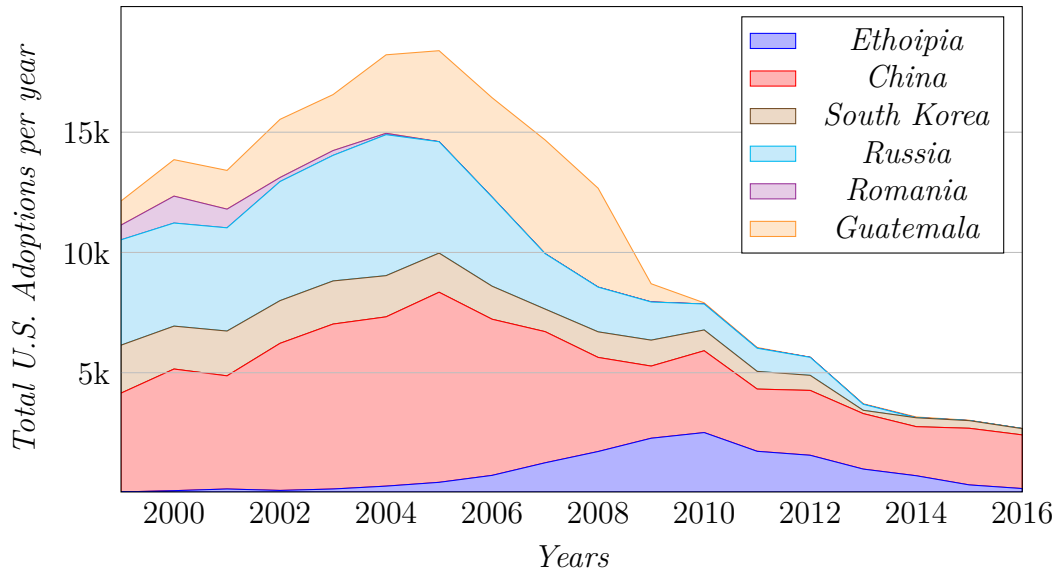


FIGURE 1.1: Adoptions to US by top countries from 1999 to 2016.

*Source: U.S. State Department*

embarrassment can spur countries to halt adoptions. After the *moratorium* on foreign adoptions in Guatemala, a former member of the country’s National Adoption Council expressed pride. “Our image as being the number one exporter of children has changed”, he said. “Guatemala has dignity”, again, he added.

Moreover, poor countries often struggle to meet The Hague Convention policy’s high standards, which include creating a central adoption authority, accrediting local agencies and tightening approval procedures, making such a rigorous international regulation more expensive. Fees have been applied on agencies, adoptive parents, orphanages and countries. This 1993 global agreement, signed by 103 countries in 2016, which meant to make adoption safer and more straightforward, has contributed to their decline.

Foreign adoptions can’t solve global poverty. But ending them merely punishes thousands of vulnerable kids and their potential parents worldwide. And that’s in nobody’s best interest.

### 1.1.2 International adoption in Italy

According to [7], [8] and [9], in 2014 Italy was the European country with the highest rate of adoptions and the second one worldwide, following the United States. This major role was confirmed in the next two-year period: 2.716 children were adopted from foreign countries in 2016/17 (see [10]), keeping Italy second worldwide for international custody transfers (see [5] and [6]). As of [2], in 1999 Italy was the forth country worldwide for international adoptions with 2.177 international adoptions, amounting to 68% of national total. Most of the Italian adoptees are from the Russia Federation (as shown in Table 1.1) and Italy is Bulgaria's favorite country of destination (in Table 1.2).

Region	Year 2016		Year 2017	
	Value	Percentage	Value	Percentage
Lombardia	258	16,7	179	15,3
Veneto	151	9,8	125	10,7
Lazio	145	9,4	112	9,6
Toscana	144	9,3	124	10,6
Campania	132	8,5	99	8,5
Puglia	123	7,9	85	7,3
Emilia-Romagna	119	7,7	86	7,4
Piemonte	93	6,0	69	5,9
Sicilia	68	4,4	44	3,8
Calabria	55	3,6	37	3,2
Liguria	52	3,4	39	3,3
<b>Friuli-Venezia Giulia</b>	<b>43</b>	<b>2,8</b>	<b>34</b>	<b>2,9</b>
Marche	42	2,7	39	3,3
Umbria	29	1,9	20	1,7
Trentino-Alto Adige	26	1,7	18	1,5
Sardegna	26	1,7	17	1,5
Abruzzo	20	1,3	28	2,4
Basilicata	13	0,8	85	7,3
Molise	9	0,6	1	0,1
Valle d'Aosta	0	0,0	0	0,0
Total	1.548	100	1.168	100

TABLE 1.4: Intercountry adoptions by Italian regions, years 2016 and 2017.

*Source: Italian Presidency of Council of Ministers, Commission for International Adoptions. See [10].*

Table 1.4 shows that Lombardia, Veneto and Lazio were the leading Italian regions for international adoption in 2016-2017, followed by Toscana and Campania. *De facto*, the northern and central portions of the country are the most active adoption-wise. Overall and regional numbers are dropping, in the same manner as it is happening all over the globe, as explained in Section 1.1.1, but a few exceptions

stand out. Abruzzo and Basilicata increased their annual adoptions, from 20 to 28 (the first), and from 13 to 85 (the latter). Even more exceptional is Valle d'Aosta, that scored a flat *zero* in both years. It must be said, though, that it's the least populated region, with only 125.000 people living in the whole region.

Most of these children, between 40 and 50%, span between 5 and 9 years of age at their arrival in Italy, and less than 15% are really young (younger than one year-olds) or the older ones (older than 10).

In 2016 and 2017, the most fertile countries of origin are the same in both years, even though they swap internal ratings: Russian Federation, Colombia, India, Hungary, Poland, Vietnam, Brazil and China (as stated in [10]). The children from these country amount for 73% of the total international adoptions.

## 1.2 Role of the pediatrician

Internationally adopted children come from countries with many endemic diseases, including hepatitis B, tuberculosis and many different intestinal parasites (as explained in [11]). These children have lived in crowded conditions, sometimes with poor standards of hygiene and inadequate nutrition. These children are malnourished, often suffer from emotional and physical neglect, and are therefore vulnerable to infectious diseases. And although children must obtain medical clearance as part of the process of applying for a visa to travel around the globe, the evaluation is usually cursory, therefore unreliable. The physician appointed to establish this sketchy health status certificate, is directed to evaluate the child for "serious contagious diseases or disabilities". However, no blood testing is required or other screening is mandated unless risk factors are identified.

According to [14], more than 50% of internationally adopted children, regardless of sex, age, and country of origin, will have a previously undiagnosed medical condition, which is identified on initial evaluation. Therefore, adoption-medicine specialized pediatricians should advise prospective parents on appropriate testing of the child after arrival in the country of destination. Early screening is crucial in order to

identify eventual pathological conditions and to prevent what could be irreversible damage. As can be found in [12] and [13], the American Academy of Pediatrics recommends careful health screening of all newly arrived international adoptees.

*What screening tests should be ordered by physicians caring for newly arrived international adoptees?* In addition to hepatitis A, B and C, HIV, congenital syphilis, other STIs, intestinal parasites, and tuberculosis by Mantoux testing, experts also recommend testing for anemia, thyroid and renal disease, vision and hearing defects, and newborn metabolic disorders when appropriate, along with careful monitoring of growth and development (according to [11], and [14]). Moreover, [11], [14], [12], [15], [16], and [17] are only some of the examples of a medical literature full to the brim, which compels physician to test for adequate immunization status. Pre-adoptive immunization records may not be assumed as truthful or correct, according to [15]. As discussed in TODO, this may happen because the cold chain gets interrupted, or because of too big intervals between somministrations.

Although concern about HIV infection causes considerable anxiety, very few internationally adopted children have arrived with this infection (see [11]). Either HIV-infected children do not survive long enough to complete an international adoption procedure or local screening identifies infected children and removes them from consideration for adoption.

Several systematic reviews and eminent periodicals focused on infectious disease risk among internationally adopted children, while data regarding prevalence and spectrum of non-infectious conditions, including special needs, are poor (see [7] and [8]).

### 1.3 Illnesses and dysfunctions under exam

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### 1.3.1 Infectious diseases

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#### 1.3.1.1 Tuberculosis

it can occur.

### 1.3.2 Blood count disorders and deficiency states

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#### 1.3.2.1 Iron-deficient anemia

it can occur.

### **1.3.2.2 Vitamin D deficiency**

it can occur too.

### **1.3.3 Height-weight disorders**

Lorem ipsum dolor sit amet, consectetur adipiscing elit. Pellentesque nibh metus, suscipit a scelerisque sit amet, rhoncus et lectus. Mauris eget erat rutrum, euismod massa id, maximus mauris. Nulla maximus, ex sit amet lacinia consequat, enim ante mollis dui, sit amet tincidunt massa felis id magna. Aenean gravida ante nec volutpat rutrum. Cras eget ullamcorper leo. Curabitur eu volutpat tellus. Integer nec ornare sapien. Fusce ipsum justo, interdum quis libero a, mattis tristique velit. Phasellus rhoncus lorem non ultrices luctus.



# Chapter 2

## Materials and Methods

### 2.1 The data set

Lorem ipsum dolor sit amet, consectetur adipiscing elit. Pellentesque nibh metus, suscipit a scelerisque sit amet, rhoncus et lectus. Mauris eget erat rutrum, euismod massa id, maximus mauris. Nulla maximus, ex sit amet lacinia consequat, enim ante mollis dui, sit amet tincidunt massa felis id magna. Aenean gravida ante nec volutpat rutrum. Cras eget ullamcorper leo. Curabitur eu volutpat tellus. Integer nec ornare sapien. Fusce ipsum justo, interdum quis libero a, mattis tristique velit. Phasellus rhoncus lorem non ultrices luctus.

#### 2.1.1 The population in exam

Lorem ipsum dolor sit amet, consectetur adipiscing elit. Pellentesque nibh metus, suscipit a scelerisque sit amet, rhoncus et lectus. Mauris eget erat rutrum, euismod massa id, maximus mauris. Nulla maximus, ex sit amet lacinia consequat, enim ante mollis dui, sit amet tincidunt massa felis id magna. Aenean gravida ante nec volutpat rutrum. Cras eget ullamcorper leo. Curabitur eu volutpat tellus. Integer nec ornare sapien. Fusce ipsum justo, interdum quis libero a, mattis tristique velit. Phasellus rhoncus lorem non ultrices luctus.

## 2.1.2 Inclusion and exclusion criteria

Lorem ipsum dolor sit amet, consectetur adipiscing elit. Pellentesque nibh metus, suscipit a scelerisque sit amet, rhoncus et lectus. Mauris eget erat rutrum, euismod massa id, maximus mauris. Nulla maximus, ex sit amet lacinia consequat, enim ante mollis dui, sit amet tincidunt massa felis id magna. Aenean gravida ante nec volutpat rutrum. Cras eget ullamcorper leo. Curabitur eu volutpat tellus. Integer nec ornare sapien. Fusce ipsum justo, interdum quis libero a, mattis tristique velit. Phasellus rhoncus lorem non ultrices luctus.

## 2.2 Data set elaboration

Lorem ipsum dolor sit amet, consectetur adipiscing elit. Pellentesque nibh metus, suscipit a scelerisque sit amet, rhoncus et lectus. Mauris eget erat rutrum, euismod massa id, maximus mauris. Nulla maximus, ex sit amet lacinia consequat, enim ante mollis dui, sit amet tincidunt massa felis id magna. Aenean gravida ante nec volutpat rutrum. Cras eget ullamcorper leo. Curabitur eu volutpat tellus. Integer nec ornare sapien. Fusce ipsum justo, interdum quis libero a, mattis tristique velit. Phasellus rhoncus lorem non ultrices luctus.

### 2.2.1 VBA expressions

Lorem ipsum dolor sit amet, consectetur adipiscing elit. Pellentesque nibh metus, suscipit a scelerisque sit amet, rhoncus et lectus. Mauris eget erat rutrum, euismod massa id, maximus mauris. Nulla maximus, ex sit amet lacinia consequat, enim ante mollis dui, sit amet tincidunt massa felis id magna. Aenean gravida ante nec volutpat rutrum. Cras eget ullamcorper leo. Curabitur eu volutpat tellus. Integer nec ornare sapien. Fusce ipsum justo, interdum quis libero a, mattis tristique velit. Phasellus rhoncus lorem non ultrices luctus.

All VBA expression can be found in Appendix A at page 30.

## 2.2.2 Cut-off values

Lorem ipsum dolor sit amet, consectetur adipiscing elit. Pellentesque nibh metus, suscipit a scelerisque sit amet, rhoncus et lectus. Mauris eget erat rutrum, euismod massa id, maximus mauris. Nulla maximus, ex sit amet lacinia consequat, enim ante mollis dui, sit amet tincidunt massa felis id magna. Aenean gravida ante nec volutpat rutrum. Cras eget ullamcorper leo. Curabitur eu volutpat tellus. Integer nec ornare sapien. Fusce ipsum justo, interdum quis libero a, mattis tristique velit. Phasellus rhoncus lorem non ultrices luctus.

### 2.2.2.1 Haemoglobin

This was a little prick.

### 2.2.2.2 MCV

This was ANOTHER little prick.

### 2.2.2.3 Circulating Iron

This was easy.

### 2.2.2.4 Vitamin D

Vitamin D is healthy. 25OH...

## 2.3 Statistical Analyses

Lorem ipsum dolor sit amet, consectetur adipiscing elit. Pellentesque nibh metus, suscipit a scelerisque sit amet, rhoncus et lectus. Mauris eget erat rutrum, euismod

---

massa id, maximus mauris. Nulla maximus, ex sit amet lacinia consequat, enim ante mollis dui, sit amet tincidunt massa felis id magna. Aenean gravida ante nec volutpat rutrum. Cras eget ullamcorper leo. Curabitur eu volutpat tellus. Integer nec ornare sapien. Fusce ipsum justo, interdum quis libero a, mattis tristique velit. Phasellus rhoncus lorem non ultrices luctus.

# Chapter 3

## Results

### 3.1 Introduction

Lorem ipsum dolor sit amet, consectetur adipiscing elit. Pellentesque nibh metus, suscipit a scelerisque sit amet, rhoncus et lectus. Mauris eget erat rutrum, euismod massa id, maximus mauris. Nulla maximus, ex sit amet lacinia consequat, enim ante mollis dui, sit amet tincidunt massa felis id magna. Aenean gravida ante nec volutpat rutrum. Cras eget ullamcorper leo. Curabitur eu volutpat tellus. Integer nec ornare sapien. Fusce ipsum justo, interdum quis libero a, mattis tristique velit. Phasellus rhoncus lorem non ultrices luctus.

### 3.2 Risultati 1

Lorem ipsum dolor sit amet, consectetur adipiscing elit. Pellentesque nibh metus, suscipit a scelerisque sit amet, rhoncus et lectus. Mauris eget erat rutrum, euismod massa id, maximus mauris. Nulla maximus, ex sit amet lacinia consequat, enim ante mollis dui, sit amet tincidunt massa felis id magna. Aenean gravida ante nec volutpat rutrum. Cras eget ullamcorper leo. Curabitur eu volutpat tellus. Integer

nec ornare sapien. Fusce ipsum justo, interdum quis libero a, mattis tristique velit. Phasellus rhoncus lorem non ultrices luctus.

### 3.3 Risultati 2

Lorem ipsum dolor sit amet, consectetur adipiscing elit. Pellentesque nibh metus, suscipit a scelerisque sit amet, rhoncus et lectus. Mauris eget erat rutrum, euismod massa id, maximus mauris. Nulla maximus, ex sit amet lacinia consequat, enim ante mollis dui, sit amet tincidunt massa felis id magna. Aenean gravida ante nec volutpat rutrum. Cras eget ullamcorper leo. Curabitur eu volutpat tellus. Integer nec ornare sapien. Fusce ipsum justo, interdum quis libero a, mattis tristique velit. Phasellus rhoncus lorem non ultrices luctus.

### 3.4 Risultati 3

Lorem ipsum dolor sit amet, consectetur adipiscing elit. Pellentesque nibh metus, suscipit a scelerisque sit amet, rhoncus et lectus. Mauris eget erat rutrum, euismod massa id, maximus mauris. Nulla maximus, ex sit amet lacinia consequat, enim ante mollis dui, sit amet tincidunt massa felis id magna. Aenean gravida ante nec volutpat rutrum. Cras eget ullamcorper leo. Curabitur eu volutpat tellus. Integer nec ornare sapien. Fusce ipsum justo, interdum quis libero a, mattis tristique velit. Phasellus rhoncus lorem non ultrices luctus.

# Chapter 4

## Discussion

Lorem ipsum dolor sit amet, consectetur adipiscing elit. Pellentesque nibh metus, suscipit a scelerisque sit amet, rhoncus et lectus. Mauris eget erat rutrum, euismod massa id, maximus mauris. Nulla maximus, ex sit amet lacinia consequat, enim ante mollis dui, sit amet tincidunt massa felis id magna. Aenean gravida ante nec volutpat rutrum. Cras eget ullamcorper leo. Curabitur eu volutpat tellus. Integer nec ornare sapien. Fusce ipsum justo, interdum quis libero a, mattis tristique velit. Phasellus rhoncus lorem non ultrices luctus.

### 4.1 Objectives achieved

Lorem ipsum dolor sit amet, consectetur adipiscing elit. Pellentesque nibh metus, suscipit a scelerisque sit amet, rhoncus et lectus. Mauris eget erat rutrum, euismod massa id, maximus mauris. Nulla maximus, ex sit amet lacinia consequat, enim ante mollis dui, sit amet tincidunt massa felis id magna. Aenean gravida ante nec volutpat rutrum. Cras eget ullamcorper leo. Curabitur eu volutpat tellus. Integer nec ornare sapien. Fusce ipsum justo, interdum quis libero a, mattis tristique velit. Phasellus rhoncus lorem non ultrices luctus.

## 4.2 Our recommendations

Lorem ipsum dolor sit amet, consectetur adipiscing elit. Pellentesque nibh metus, suscipit a scelerisque sit amet, rhoncus et lectus. Mauris eget erat rutrum, euismod massa id, maximus mauris. Nulla maximus, ex sit amet lacinia consequat, enim ante mollis dui, sit amet tincidunt massa felis id magna. Aenean gravida ante nec volutpat rutrum. Cras eget ullamcorper leo. Curabitur eu volutpat tellus. Integer nec ornare sapien. Fusce ipsum justo, interdum quis libero a, mattis tristique velit. Phasellus rhoncus lorem non ultrices luctus.

## 4.3 Future work

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# Chapter 5

## How to Do

This is all I know on LaTeX up to now.

### 5.1 Including Sections and Subsections

This is my first section.

#### 5.1.1 I like myself

I'm nice.

#### 5.1.2 but I'm weird

but fun.

##### 5.1.2.1 LOST OF FUN!

Writing writing and writing.

### 5.1.2.2 I'm calm and shit

I write stuff in subsubsections.

**And lastly this is new and amazing PARAGRAPH:** You can write whatever you want and it's pretty cool and new. I still like subsubsections more.

## 5.2 Including references and citations

This is pretty simple to cite: developed as open-source C++ software by Rudolf Biczok [18]. We'll learn more about this as we go. Let's see if they change order [7]. They should've change [8].

### 5.2.1 Referencing images and tables!

So you can see figure 5.1 at page 28. AMAZING  
OR you can also see the table 5.1 at page 28!

### 5.2.2 Referencing chapters and subchapters

You can also ref chapters, as Chapter Results 3.

### 5.2.3 Using footnotes

Let's try this out.<sup>1</sup> And another one to see if it is progressive and shit.<sup>2</sup>

---

<sup>1</sup>This is my first footnote.

<sup>2</sup>CAREFUL! Don't leave any spaces before the command or they will be rendered.

I'll try now to “place them manually”. This is were the sign is.<sup>3</sup>  
Somewhere else in the text. I insert what it contains.

## 5.3 Including quotes

This is how a quote looks.

From an evolutionary perspective, virtual reality is seen as a way to overcome limitations of standard human-computer interfaces; from a revolutionary perspective, virtual reality technology opens the door to new types of applications that exploit the possibilities offered by presence simulation.

And also in text quotes: “[by] immersing the user in the solution, virtual reality reveals the spatially complex structures in computational science in a way that makes them easy to understand and study”.

And dots...

## 5.4 Including URLs

We can include `https://github.com/vrcranfield/UnityApplication`.

## 5.5 Including code

The following code is written by Lorenzo:

---

<sup>3</sup>This is my footnote!

```
=IF(
  OR(
    E68 = "Russia";
    E68 = "Albania";
    E68 = "Bulgaria";
    E68 = "Ungheria";
    E68 = "Ucraina";
    E68 = "Moldavia";
    E68 = "Romania"
  );
  "Europa dell'Est";
  IF(
    OR(
      E68 = "Burkina Faso";
      E68 = "Etiopia";
      E68 = "Costa d'Avorio";
      E68 = "Congo";
      E68 = "Guinea Bissau";
      E68 = "Africa";
      E68 = "Ghana";
      E68 = "Benin"
    );
    "Africa";
    IF(
      OR(
        E68 = "Colombia";
        E68 = "Brasile";
        E68 = "Guatemala";
        E68 = "Peru";
        E68 = "Costa Rica"
      );
      "America del Sud";
      IF(
        OR(
          E68 = "Armenia";
          E68 = "India";
          E68 = "Cina";
          E68 = "Vietnam";
          E68 = "Sri Lanka";
          E68 = "Siberia";
          E68 = "Nepal";
          E68 = "Filippine"
        );
        "Asia";
        ""
      )
    )
  )
)
```

## 5.6 Formatting Text

This is **BOLD** *This is ITALIC* This is SANS SERIF This is TRUE TYPE

In this sentence THIS IS TINY. THIS WHOLE SENTENCE IS TINY.

I go back to normal.

Then I can go for large, or Large, or Larger, or Huge and even HUGE.

## 5.7 Including bulleted list

Lorem ipsum dolor sit amet, consectetur adipiscing elit. Nam quam tellus, venenatis a consectetur non, pretium ac nunc. Nullam eu tellus sed augue laoreet scelerisque.

- The first item of your list
- The second item of your list
- The third item of your list

Lorem ipsum dolor sit amet, consectetur adipiscing elit. Nam quam tellus, venenatis a consectetur non, pretium ac nunc. Nullam eu tellus sed augue laoreet scelerisque. Curabitur efficitur, dolor ut pretium fermentum, nisi enim pulvinar nunc, non bibendum urna odio nec neque. Cras tellus turpis, posuere in dictum vitae, vestibulum quis velit.

1. The first item of your list
2. The second item of your list
3. The third item of your list

Lorem ipsum dolor sit amet, consectetur adipiscing elit. Nam quam tellus, venenatis a consectetur non, pretium ac nunc. Nullam eu tellus sed augue laoreet scelerisque. Curabitur efficitur, dolor ut pretium fermentum, nisi enim pulvinar nunc, non bibendum urna odio nec neque. Cras tellus turpis, posuere in dictum vitae, vestibulum quis velit.

- a) The first item of your list
- b) The second item of your list
- c) The third item of your list

## 5.8 Including Figures

Orci varius natoque penatibus et magnis dis parturient montes, nascetur ridiculus mus. Nam vulputate finibus malesuada. Praesent at egestas turpis. Vivamus vitae tellus malesuada, laoreet ex ac, venenatis est. Aliquam dictum tincidunt libero, cursus posuere arcu sodales non. In sed metus sit amet arcu vestibulum mollis ut vel nibh. Nam non velit tortor. Integer ac sapien a purus porta convallis. In vestibulum aliquam nunc vitae faucibus. Etiam tristique iaculis orci, vel aliquam felis accumsan et. Nulla ultricies, nisl eu malesuada lobortis, ante metus faucibus libero, vitae blandit odio enim sit amet tortor.

## 5.9 Including Tables

Orci varius natoque penatibus et magnis dis parturient montes, nascetur ridiculus mus. Nam vulputate finibus malesuada. Praesent at egestas turpis. Vivamus vitae tellus malesuada, laoreet ex ac, venenatis est. Aliquam dictum tincidunt libero, cursus posuere arcu sodales non. In sed metus sit amet arcu vestibulum mollis ut vel nibh. Nam non velit tortor. Integer ac sapien a purus porta convallis. In vestibulum aliquam nunc vitae faucibus. Etiam tristique iaculis orci, vel aliquam



FIGURE 5.1: Living room as I imagine it

*Source: Photo courtesy of HTC*

felis accumsan et. Nulla ultricies, nisl eu malesuada lobortis, ante metus faucibus libero, vitae blandit odio enim sit amet tortor.

Day	Max Temp	Min Temp
Mon	20	13
Tue	22	14
Wed	23	12
Thurs	25	13
Fri	18	7
Sat	15	13
Sun	20	13

(A) First Week

Day	Max Temp	Min Temp
Mon	17	11
Tue	16	10
Wed	14	8
Thurs	12	5
Fri	15	7
Sat	16	12
Sun	15	9

(B) Second Week

TABLE 5.1: Max and min temps recorded in the first two weeks of July

<b>ParaView</b>			
<b>VTK</b>			
<b>OpenGL</b>	<b>MPI</b>	<b>OpenVR</b>	<b>Etc.</b>

TABLE 5.2: ParaView-VTK Architecture (simplified)



# Appendix A

## Data set elaboration: VBA expressions

This appendix provides all the code used in this thesis to elaborate the data set. Visual Basic for Application (VBA) is the programming language chosen for this purpose, as the most effective and manageable way of elaborating data in excel sheets. Further information can be found throughout this thesis, especially in Section 2.2 at page 15.

In the following appendix, cells are indicated as combination of a letter (identifying the column) and a number (identifying the line), as they originally were in the database. Every line represents a single child's evaluation; every column represents one of the examined parameters. The full column-parameter correspondence can be found in following Table A.1.

Column	Parameter	Units or cell type	Description
<i>A</i>	First and last name	<i>text</i>	The name of the kid. <sup>1</sup>
<i>B</i>	Sex	<i>text</i>	The sex of the child.
<i>C</i>	Age (in months)	<i>months</i>	The age of the child.

---

<sup>1</sup>Although registering the patient's full name exposed the research to a possible privacy breach risk, it was added nonetheless to easily identify each patient as the data set got larger through the years.

<i>D</i>	Age (in years)	<i>years</i>	The age of the child. Further information on how this was obtained can be found at Section A.1.
<i>E</i>	Country of origin	<i>text</i>	Where the child comes from.
<i>F</i>	Geographic area of origin	<i>text</i>	<i>E</i> was divided in 4 macro-geographic areas. See A.2 for further information.
<i>G</i>	Time in Italy	<i>months</i>	Months spent in Italy before being examined by our physicians.
<i>H</i>	Weight	<i>percentile</i>	Percentile in which the child fits for his weight at time of examination.
<i>I</i>	Pathological weight	<i>boolean</i>	Is the child underweight for his/her age?
<i>J</i>	Height	<i>percentile</i>	Percentile in which the child fits for his height at time of examination.
<i>K</i>	Pathological height	<i>boolean</i>	Is the child short for his/her age?
<i>L</i>	Haemoglobin	<i>g/dl</i>	Is the child short for his/her age?
<i>M</i>	Pathological haemoglobin	<i>boolean</i>	Is the child short for his/her age?
<i>N</i>	MCV	<i>fl</i>	Is the child short for his/her age?
<i>O</i>	Pathological MCV	<i>boolean</i>	Is the child short for his/her age?
<i>P</i>	Circulating iron	<i>µg/dl</i>	Is the child short for his/her age?
<i>Q</i>	Pathological circulating iron	<i>boolean</i>	Is the child short for his/her age?
<i>R</i>	Ferritin	<i>ng/ml</i>	Is the child short for his/her age?
<i>S</i>	Pathological ferritin	<i>boolean</i>	Is the child short for his/her age?
<i>T</i>	Pathological ferritin	<i>boolean</i>	Is the child short for his/her age?
<i>U</i>	Pathological ferritin	<i>boolean</i>	Is the child short for his/her age?
<i>V</i>	Pathological ferritin	<i>boolean</i>	Is the child short for his/her age?
<i>X</i>	Pathological ferritin	<i>boolean</i>	Is the child short for his/her age?
<i>W</i>	Pathological ferritin	<i>boolean</i>	Is the child short for his/her age?
<i>Y</i>	Pathological ferritin	<i>boolean</i>	Is the child short for his/her age?
<i>Z</i>	Pathological ferritin	<i>boolean</i>	Is the child short for his/her age?
<i>AA</i>	Pathological ferritin	<i>boolean</i>	Is the child short for his/her age?
<i>AB</i>	Pathological ferritin	<i>boolean</i>	Is the child short for his/her age?

TABLE A.1: Full column-parameter correspondence, including units of measurement or cell type and a short description

## A.1 Age (in months)

This VBA expression checks the *Age (in months)* column (C) and, if it's not empty, it divides its value by 12, rounding it down, just as age works.

The `ROUNDDOWN` function was implemented in order to avoid overestimating child's age.

```
=IF(  
    C2 <> " ";  
    ROUNDDOWN(  
        C2 / 12;  
        0  
    );  
    ""  
)
```

## A.2 Geographic area of origin

To further understand how geographic origin influenced the results of our screening program, the countries of origin were grouped up in 4 major continents or areas with the following excel expression. The chosen macro-areas were:

- Africa
- Asia
- Eastern Europe
- South America

```
=IF(  
    OR(  
        E2 = "Russia";  
        E2 = "Albania";  
        E2 = "Bulgaria";  
        E2 = "Hungary";
```

```
E2 = "Ukraine";
E2 = "Moldavia";
E2 = "Romania"
);
"Eastern Europe";
IF(
  OR(
    E2 = "Burkina Faso";
    E2 = "Ethiopia";
    E2 = "Ivory Coast";
    E2 = "Congo";
    E2 = "Guinea Bissau";
    E2 = "Africa";
    E2 = "Ghana";
    E2 = "Benin"
  );
  "Africa";
  IF(
    OR(
      E2 = "Colombia";
      E2 = "Brazil";
      E2 = "Guatemala";
      E2 = "Peru";
      E2 = "Costa Rica"
    );
    "South America";
    IF(
      OR(
        E2 = "Armenia";
        E2 = "India";
        E2 = "China";
        E2 = "Vietnam";
        E2 = "Sri Lanka";
        E2 = "Siberia";
        E2 = "Nepal";
        E2 = "Philippines"
      );
      "Asia";
      ""
    )
  )
)
```

## A.3 Pathological values

The data set contained numerical values for many laboratory analyses. Cut-off values for these results were established via the most recent literature review, as explained in Section 2.2.2. In the following sections, the code used to establish which ones were pathological and which were not, is displayed and shortly explained.

### A.3.1 Weight and height

These parameters, since they had already been converted to percentile values, were easily implemented with the following simple VBA expression:

```
=IF(  
    H2 <> "";  
    IF(  
        H2 <= 10;  
        1;  
        0  
    );  
    ""  
)
```

### A.3.2 Haemoglobin

Hemoglobin required a more complicated and sophisticated expression, in order to be stratified, because hemoglobin pathological cut-offs depend on various factors, as described in Section 2.2.2.1. Moreover mild, moderate and severe anemias had to be separated in order to properly evaluate the child's health status; each one had an arbitrary value of 1 (*mild*), 2 (*moderate*) or 3 (*severe*) associated to it.

```
=IF(  
    L2 <> "";  
    IF(  
        H2 <= 10;  
        1;  
        0  
    );  
    ""  
)
```



```

        C2 >= 132;
        C2 < 168
    );
    IF(
        L2 >= 12;
        0;
        IF(
            AND(
                L2 < 12;
                L2 >= 11
            );
            1;
            IF(
                AND(
                    L2 < 11;
                    L2 >= 8
                );
                2;
                3
            )
        )
    )
);
""
)

```

### A.3.3 MCV

As just described for haemoglobin, MCV required more complicated techniques in order to be stratified, because of its variability (through age, sex, ecc...), as described in Section 2.2.2.2. Moreover, boolean results couldn't be accepted for this parameter, so arbitrary values were used to appropriately identify microcytic (1) and macrocytic (2) anemias.

```

=IF(
    N2 <> "";
    IF(
        B2 = "F";
        IF(
            AND(

```

```
        C2 >= 0;  
        C2 < 60  
    );  
    IF(  
        N2 > 85;  
        2;  
        IF(  
            AND(  
                N2 <= 85;  
                N2 >= 69  
            );  
            0;  
            1  
        )  
    );  
    IF(  
        AND(  
            C2 >= 60;  
            C2 < 120  
        );  
        IF(  
            N2 > 89;  
            2;  
            IF(  
                AND(  
                    N2 <= 89;  
                    N2 >= 75  
                );  
                0;  
                1  
            )  
        );  
        IF(  
            AND(  
                C2 >= 120;  
                C2 < 168  
            );  
            IF(  
                N2 > 92;  
                2;  
                IF(  
                    AND(  
                        N2 <= 92;  
                        N2 >= 78  
                    );  
                    0;  
                    1  
                )  
            )  
        )  
    )
```



```
)  
)  
);  
IF(  
    B2 = "M";  
    IF(  
        AND(  
            C2 >= 0;  
            C2 < 60  
        );  
        IF(  
            N2 > 85;  
            2;  
            IF(  
                AND(  
                    N2 <= 85;  
                    N2 >= 71  
                );  
                0;  
                1  
            )  
        );  
        IF(  
            AND(  
                C2 >= 60;  
                C2 < 120  
            );  
            IF(  
                N2 > 88;  
                2;  
                IF(  
                    AND(  
                        N2 <= 88;  
                        N2 >= 76  
                    );  
                    0;  
                    1  
                )  
            );  
            IF(  
                AND(  
                    C2 >= 120;  
                    C2 < 168  
                );  
                IF(  
                    N2 > 90;  
                    2;  
                    IF(  
                        AND(  

```

```
        N2 <= 90;  
        N2 >= 76  
    );  
    0;  
    1  
    )  
    )  
    )  
    )  
    );  
    ""  
    )  
    );  
    ""  
    )
```

### A.3.4 Circulating iron

The following VBA expression was used to establish whether circulating iron levels were insufficient.

```
=IF(  
    P2 <> "";  
    IF(  
        AND(  
            P2 >= 16;  
            P2 <= 129  
        );  
        0;  
        1  
    );  
    ""  
)
```

### A.3.5 Ferritin

The following VBA expression was used to identify pathological ferritin values. These were, again, stratified for *mild* (1), *moderate* (2) and *severe* (3) deficiencies.

```
=IF(  
  R2 <> " ";  
  IF(  
    R2 >= 20;  
    0;  
    IF(  
      AND(  
        R2 < 20;  
        R2 >= 15  
      );  
      1;  
      IF(  
        AND(  
          R2 < 15;  
          R2 >= 10  
        );  
        2;  
        IF(  
          R2 < 10;  
          3  
        )  
      )  
    )  
  );  
  ""  
)
```

### A.3.6 Vitamin D

The following VBA expression was used to establish whether Vitamin D (serum 25-hydroxycholecalciferol) values were *insufficient* (1), *deficient* (2) or *severely deficient* (3). The predictive choice for this marker is explained at Section 2.2.2.4.

```
=IF(  

```

```
AA2 <> " ";  
IF(  
    AA2 >= 50;  
    0;  
    IF(  
        AND(  
            AA2 < 50;  
            AA2 >= 25  
        );  
        1;  
        IF(  
            AND(  
                AA2 < 25;  
                AA2 >= 10  
            );  
            2;  
            IF(  
                AA2 < 10;  
                3  
            )  
        )  
    )  
);  
""  
)
```

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