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**Original Research**

# The role of the community pharmacy in the fight against antimicrobial resistance: A Survey in Italy

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**Abstract**

**Background:** In the last decades, the inappropriate use of anti-microbials has accelerated the spread of AntiMicrobial Resistances (AMR). Italy has been among the countries in Europe with the highest percentages of resistance to the principal classes of antibiotics. **Objective.** in 2024 we developed a nationwide project in Italy titled "Antimicrobial resistance: it's time to act". The main objectives were: to increase the knowledge among community pharmacists of the phenomenon of AMR and Group A Streptococcus (GAS) infections; to investigate, among the population attending community pharmacies, the knowledge of the risks associated with the incorrect use of antibiotics (Phase 1), and the prevalence of GAS infections (Phase 2). **Methods.** The study was conducted in Italian in community pharmacies. Phase 1 was subdivided into two phases: in Phase 1A, the investigation was carried out by using a self- administered questionnaire, whereas in Phase1B, the same questionnaire was administered to users by the community pharmacist. In Phase 2, data were gathered recording the results of rapid tests to detect GAS infections. **Results.** During Phase 1, data was collected in 778 pharmacies. 14.507 subjects were interviewed. During phase 2, 218 pharmacies participated and 1.914 subjects were enrolled. The Phase 1 investigation showed that there was a significant lack of awareness of AMR among the study population. The data collected enable us to highlight the need for health care professionals to provide the education of the Italian population on the issue of AMR. Regarding Phase 2, it is possible to affirm that the presence of general symptoms consistent with a GAS infection was not at all predictive of a positive result to the rapid test with the exception of the 0-10-year-old age group. Considering, however, more specifically those who declared a set of symptoms affecting the throat, the likelihood that a subject has a positive test rises significantly with age. **Conclusions.** In light of these results, and the fact that community pharmacies are among the health services most easily accessible to the general public, their active involvement in any campaign to raise awareness and educate the population on the topic of AMR should be considered.

**Keywords:** AntiMicrobial Resistance, AMR, questionnaire, information campaign, community pharmacies

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## INTRODUCTION

The introduction of antimicrobial pharmaceutical therapies in the last century made it possible to cure infections that would previously have been fatal. Unfortunately, in the last few decades, the excessive and inappropriate use of anti-microbials has accelerated the spread of antimicrobial-resistant microorganisms, making pharmacological treatments les efficacious[1]. AntiMicrobial Resistance (AMR) is a natural adaptive process found in microorganisms such as bacteria, viruses, fungi and parasites, which acquire the ability to survive and replicate in the presence of a concentration of an antimicrobial agent which would normally be sufficient to inhibit their growth or kill microorganisms of that species. This phenomenon makes the treatment of infections more challenging and leads to an increased risk of serious illness or morbidity. The term AMR also includes Antibiotic Resistance (AR), which is instead limited to antibacterial agents[2-3].

AMR was already a growing issue in the 1950s. However, it was not given due attention as it was still possible to develop new classes of antimicrobials. This led to the misguided notion that the problem of resistance could easily be overcome by synthesizing a new molecule[4-5]. It was only in the 1970s that this problem finally had to be faced when, owing to the ever more widespread use of antibiotics, the incidence of cases of resistance grew exponentially, particularly in developing countries where the use of antimicrobial pharmaceuticals was subject to less rigorous levels of control and regulation[6]. Another critical factor in the increase in AMR is the inappropriate use





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of antimicrobials in agriculture and animal breeding. The resistant microorganisms that develop in this environment can easily be transferred to humans through direct contamination from biological substances (urine, faeces, milk, or saliva), or indirectly through contact with or ingestion of contaminated food products of animal origin[7]. In this context, it should be noted that there is conclusive evidence that the abuse of antibiotics in agriculture and breeding is ineffective from an economic standpoint: In countries such as Denmark and Sweden, the banning and restriction of antibiotics on farms has had negligible effects on productivity[8].

Currently, at least 700,000 people die every year globally as a result of AMR. Without new or better treatments, the World Health Organisation (WHO) foresees that this number may rise to ten million by the year 2050, highlighting a concerning health issue of prime importance[9]. It is now clear that the phenomenon of AMR represents a true global health crisis with serious consequences, not only in terms of unsuccessful pharmacological treatment and increased mortality, but also in terms of costs to the health system[10]. An exact estimate of the economic impact of resistant bacterial infections certainly represents a global challenge, but in the USA alone, hospital-acquired infections owing to antibiotic-resistant pathogens cause an average of 99,000 deaths each year[6].

According to WHO estimates, as of November 2023, 178 countries have drawn up national multi-sectorial action plans on antimicrobial resistance: However, in 2023, only 27% of countries reported having actually implemented their national action plans, and only 11% had allocated national budgets to do so. An effective "One Health" multi-sectorial response to antimicrobial resistance calls for specific competencies and actions from each sector to be delivered in a forceful and coordinated manner. In the human health sector, the implementation of national action plans has often been piecemeal, and confined to hospitals, notwithstanding the fact that the bulk of pharmaceutical use takes place outside of this environment[11]. The seriousness of the phenomenon and its global scale has pushed the WHO and the European Union (EU) to institute numerous surveillance systems in recent years such as the digital veterinary prescription[12]. The situation regarding AMR after these measures has not been uniform in the EU, and strains of bacteria harbouring antibiotic resistance have been discovered with increasing frequency, notably in parts of Eastern and Southern Europe[13].

Italy has, for many years, been among the countries in Europe with the highest percentages of resistance to the principal classes of antibiotics. To curb this, in 2022, the "Piano Nazionale di Contrasto all'Antimicrobico-Resistenza 2022-2025" (National Plan to Eliminate Antimicrobial Resistance 2022-2025) was approved: this plan lays out the direction and measures that national, regional, and local institutions must take to ensure greater control over the phenomenon of AMR in the coming years; it identifies strategies in line with the objectives of the action plans drawn up by the WHO and the EU. The surveillance of antibiotic resistance in humans is defined as one of the pillars of the national plan, and a key point in verifying the impact of the strategies adopted. In this light, it is essential to adopt appropriate containment measures against AMR based on the consideration that its growth can be contrasted not only by measures based on containment strategies to halt the spread of multi-resistant bacteria in healthcare facilities, but also through education programs targeting the general population on the correct use of antibiotics[10].

In the context of antibiotic therapies, due care and attention must be given to the problem of infections caused by Group A Streptococcus (GAS), a bacterium commonly found in the throat, and on the skin, which in normal physiological conditions does not lead to any disturbances[14]. According to an Italian Health Ministry report, a growing number of cases of invasive Group A Streptococcal have been observed in France, Ireland, Belgium, Sweden and the UK. Consequently, there has been a correlated increase in infections and fatalities due to GAS[15-17]. While in the majority of cases, GAS provokes minor infections such as tonsillitis, pharyngitis, impetigo, cellulitis and scarlet fever, it is sometimes possible to observe invasive diseases that can culminate in the patient's decease. GAS infections prevalently affect the school-age population, reaching a peak in the winter months. Although the WHO has not identified an increase in antibiotic resistance specifically for this particular type of infection, the need for a reduction in the use of antimicrobial therapies overall in order to curb AMR would imply that there should be a corresponding regulation of the use of such therapies in the treatment of GAS overt infections[15-16].

Community pharmacies, given their widespread distribution on the territory, accessibility, and extended opening hours, could play a vital role in any campaign against antimicrobial resistance. In Italy, there is a network of over 20,000 community pharmacies, a ratio of 1 for every 2,900 inhabitants, and nearly every town has at least one pharmacy[18]. Hence, pharmacies are frequently the first point of contact for the National Health System with the population, and, considering their relationship of trust with the local community, could take on an important role in any education campaign, participating effectively in imparting knowledge regarding the correct use of antibiotics.

Several campaigns have already involved Italian community pharmacies in the health education of the general population, and in secondary and tertiary prevention campaigns[19-34]. The satisfying results obtained in these previous studies have led us to postulate that there is a role for pharmacists in the context of AMR.

In order to test this hypothesis, we developed a nationwide project in Italy titled "Antimicrobicoresistenza: è tempo di agire" (Antimicrobial resistance: it's time to act).

In particular, having demonstrated the usefulness of the questionnaire method for data gathering in community pharmacies in previous studies[24, 27-29, 32-33], we designed the study as a survey with a number of objectives. The main objectives were to increase the knowledge and levels of awareness among community pharmacists of the phenomenon of AMR and GAS infections through a specific training course developed to more

stimulate a conscious and scientifically correct use of antibiotics by patients. Moreover, we wished to investigate, among the population attending community pharmacies, the knowledge of the risks associated with the incorrect use of antibiotics, and the prevalence of GAS infections. Regarding GAS infections, we also wished to evaluate whether the availability of rapid testing systems in pharmacies might be a useful instrument to optimize the prescription of antibiotics by physicians.

The study had the patronage of the Italian Federation of Pharmacists' Orders (FOFI).

## METHODS

The study was conducted nationally in Italy in community pharmacies which volunteered to participate, and was organised into two phases: an investigation into the use of antibiotics and the awareness of the phenomenon of AMR among the Italian population (Phase 1), and an evaluation of the prevalence of GAS-positive patients (Phase 2)

**Phase 1**

Phase 1 was further subdivided into two phases: in Phase 1A, the investigation was carried out by using a self- administered questionnaire, i.e., completed by participants themselves, whereas in Phase1B, the same questionnaire was administered to users by the community pharmacist. The questionnaire used in Phase 1A and Phase 1B was adopted and translated into Italian from the original WHO model "Antibiotic resistance: multi-country public awareness survey". The questionnaire was first tested on a small group of subjects to ensure that it was readable, comprehensible, and reliable; thereafter, it was tested on more than 1,800 community pharmacy users in Piedmont, a region in the North-West of Italy[35]. The questionnaire was made up of twenty-two questions (fourteen multiple-choice questions, five polar questions and three open-ended questions)

The respondents were recruited according to the following criteria: on alternate days, the community pharmacists would ask the first user to enter the pharmacy at opening time, and the first to enter at 4.00 pm to take part in the study, or the first user to enter the pharmacy after 11.00 am and then after 6.30 pm. These inclusion criteria were chosen so as to interview the widest possible range of subjects from diverse socio-demographic backgrounds: the retired and non-working are more likely to enter a pharmacy at the morning opening time, whereas working people more often enter after 6.00 pm. All the respondents were over 18 years old. The users who agreed to take part in the study from 1st February 2024 to 16th March 2024 were enrolled in Phase 1A of the study; the users who agreed to take part in the study from 17th March 2024 to 30th April 2024 were enrolled in Phase 1B of the study. After completing the questionnaire, the respondents in Phase 1 were provided with informational literature and received a brief explanation from the pharmacist, based on Ministry of Health reports, regarding the phenomenon of AMR. The sample size calculation were done considering the comparison between people who know and who do not know AMR. The required sample size for a power of 90% was 1,048 (if the 45% knows AMR) or 6,564 (if the 48% knows AMR) subjects. Considering the final percentage of people who know AMR (44%) and the final sample size (9,997 in Phase 1A, 4,510 Phase 1B) the power is 99%.

**Phase 2**

In Phase 2, data were gathered recording the results, performed in the course of community pharmacist's routine activities as foreseen by the current legislation in Italy[36], of rapid tests to detect GAS infections. Specifically, data were gathered anonymously concerning age, sex, and the result of the rapid test. Subjects were enrolled who, when questioned by the pharmacist, displayed a typical symptomology due to GAS: hence, sore throat, red throat, tonsil stones, odynophagia, or temperature. Exclusion criteria included taking systemic-use antibiotics, or the presence of symptoms such as cough or rhinitis, which are not characteristic of GAS infections. Phase 2 was conducted between 1st February 2024 and 30th April 2024. All the pharmacies used the same brand and lot number of rapid test kits (Group A Streptococcus Test Kit Colloidal Gold; diagnostic sensitivity: 96.55%; diagnostic specificity: 98.08%, accuracy: 97.16%; Shenzhen Lvshiyuan Biotechnology Co. Ltd, Dapeng New District, Shenzhen, China).

**Training of Community Pharmacists**

The pharmacists who administered the study in the pharmacies participated in a specific training course, delivered by distance learning, and regarding the methodology of enrolment of users, the execution of the various phases of the study, as well as training on AMR, GAS and the correct procedure for administering the rapid test of the type employed in the study; moreover, specifically for Phase 1B of the study, the pharmacists were provided with training on how to administer the questionnaire without introducing biases or influencing the answers of the respondents. Following the training course, the knowledge acquired by the pharmacists was verified with an on-line multiple-choice quiz. Pharmacists who correctly answered the 80% of the questions were considered eligible. Two pharmacists participated for each pharmacy and the participation was on a voluntary and free basis.

**Statistical methods**

All continuous variables are reported as mean and standard deviation, while categorical ones as frequencies and percentages. The primary objective of the study was to explore the knowledge of the AMR problem in the population (Phase 1), and to evaluate the prevalence of GAS positive patients (Phase 2). In Phase 1, two questions were considered: "Have you ever heard of AMR?" and "Do you know what AMR is?". In the first case, a "yes" answer is classified as "has heard of AMR", while "no" or "I don't know" are classified as "has not heard of AMR". In the second one, the correct answer is classified as "aware of AMR", while all the wrong ones and "I don't know" as "not aware of AMR". To compare the two classes in both questions, chi-squared test was used, and results are presented in terms of p-values. A comparison between the habit of receiving and giving advice on antibiotic assumption was carried out

with Cohen's kappa coefficient with 95% confidence interval (95%CI).

In Phase 2, a logistic model was used to explore the link between symptoms and positivity. Results are presented in terms of Odds Ratio (OR) with relative 95%CI. Other comparisons were carried out using chi-squared test, with relative p-values. All statistics were done with SAS® Statistical Software v.9.4 (SAS Institute Inc. 2023. SAS/STAT® 15.3 User's Guide. Cary, NC), considering an alpha-error equal to 5%.

## RESULTS

**Phase 1**

The number of participating pharmacies was 469 in Phase 1A, and 309 in Phase 1B. The majority of pharmacies were located in the North of Italy (62.60% in Phase 1A, 60.02% in Phase 1B), but there were a significant number of pharmacies from Central Italy (12% both in Phase 1A and in Phase 1B), and from the South of Italy (24.80% in Phase 1A, 28.22% in Phase 1B). Most of the pharmacies involved in the study (60.42% in Phase 1A, 63.11% in Phase 1B) were located in urban areas.

Over the course of Phase 1A, 9,997 questionnaires were completed by users, whereas 4,510 respondents were interviewed in Phase 1B. The average time to complete the questionnaire was 8.2 minutes in Phase 1A, while 8.9 minutes was required on average to complete the questionnaire in Phase 1B. The age group most commonly participating in the survey was 50 years old to 60 years old (24.23% in Phase 1A, 22.75% in Phase 1B); the average age of participants was 52 years old, with a minimum of 18 years old and a maximum of 96 years old. Other socio-demographic variables are reported in Table 1.

**Use of Antibiotics**

A large majority of respondents (76.23% Phase 1A, 76.43% Phase 1B) declared that they had never taken antibiotics without a prescription. Similarly, only a small percentage (4.12% Phase 1A, 4.57%% Phase 1B) declared that they had purchased medicine for their pets without a prescription.

Most respondents declared that on receiving a prescription for antibiotics, they had also received instructions from the prescribing medical doctor (79.15% Phase 1A, 76.25% Phase 1B) regarding the correct management of the therapy. Similarly, a majority of respondents had received instructions on the correct use of antibiotics from their pharmacist (78,47% Phase 1A, 72,35% Phase 1B). Some respondents (24.29% Phase 1A, 30.32% Phase 1B) affirmed that they had received information from either their medical doctor or the dispensing pharmacist (medical doctor only: 12.5% Phase 1A, 17.11% Phase 1B; pharmacist only: 11.78% Phase 1A, 13.21% Phase 1B)

Just under a quarter of enrolled subjects (24.94% Phase 1A, 23.10% Phase 1B) declared that they had recommended antibiotics to a relative or friend; this percentage rises if one examines the specific group of respondents employed in the healthcare sector (38.35% Phase 1A, 34.73% Phase 1B), or those residing in the regions in the South of Italy (29.64% Phase 1A, 29.23% Phase 1B). Furthermore, in approximately 40% of cases (42.79% Phase 1A, 42.36% Phase 1B), the respondents declared that they had received advice from relatives or friends regarding antibiotic therapies. This percentage rises to more than 45% (46.62% Phase 1A, 48.13% Phase 1B) if the regions of Southern Italy alone are considered. Approximately half of all users keep antibiotics in the home (56.0% Phase 1A, 52.84% Phase 1B).

Regarding the prescribed therapy, many declared that they had interrupted the course of antibiotics only after completing the course prescribed by their medical doctor (84.37% Phase 1A, 82.99% Phase 1B). Female respondents demonstrated a greater adherence to therapy (87.53% Phase 1A, 86.6% Phase 1B) than male respondents (79.03% Phase 1A, 78.44% Phase 1B). Moreover, male respondents (9.44% Phase 1A, 7.61% Phase 1B), and respondents residing in regions in the south of Italy (7.95% Phase 1A, 7.33% Phase 1B) both declared that they had interrupted the therapy as soon as they felt better with a frequency higher than the average for the whole population interviewed (6.11% Phase 1A, 5.7% Phase 1B).

Less than 15% of users (8.93% Phase 1A, 12.79% Phase 1B) are able to identify the pathologies, two among those listed, for which antibiotics are recommended. Again, the responses are more accurate when the respondent is female (10.24% Phase 1A, 13.83% Phase 1B), employed in the healthcare sector (16.86% Phase 1A, 26.51% Phase 1B), or a student in healthcare disciplines (14.06% Phase 1A, 15.49% Phase 1B). Moreover, those knowing the meaning of the term AMR provided more correct answers (13.38% Phase 1A, 17.33% Phase 1B). The majority of the respondents (74.61% Phase1A, 78.25% Phase 1B) are aware of the fact that antibiotics should be taken for toothache only in specific cases.

**Knowledge and Awareness of AMR**

More than half of respondents (62.46% Phase 1A, 60.91% Phase 1B) declared that they had heard of the term AMR, females (65.83% Phase 1A, 63.55% Phase 1B) more frequently than males (56.48% Phase 1A, 56.63% Phase 1B), but less frequently in the South of Italy (60.31% Phase 1A, 56.68% Phase 1B).The percentage of respondents that had heard of AMR further declined among students of non-health faculties (54.55% Phase 1A, 54.36% Phase 1B) and among the retired (51.85% Phase 1A, 52.19% Phase 1B).

However, when awareness of the term AMR was investigated in greater depth, this is correctly defined by less than half of respondents (44.11% Phase 1A, 45.3% Phase 1B). Females (45.48% Phase 1A, 48.26% Phase 1B), respondents declaring that they were employed in the healthcare sector (72.9% Phase 1A, 76.23% Phase 1B), and students studying health-related disciplines (75.78% Phase 1A, 68.42% Phase 1B) have a more accurate knowledge of the meaning of the term AMR. In contrast, the respondents who least frequently demonstrated an accurate knowledge of the term AMR were the retired (35.32% Phase 1A, 35.84% Phase 1B), and inhabitants in the south of Italy (39.28% Phase 1A, 41.29% Phase 1B).

**Table 1.** Phase 1 results

| Variable | Options | N (%) Phase 1A | N (%) Phase 1B | p-value |
|---|---|---|---|---|
| Gender | Female | 6447 (64.49%) | 2870 (63.64%) | 0.0118 |
| | Male | 3487 (34.88%) | 1591 (35.28%) | |
| | I prefer not to specify | 63 (0.63%) | 49 (1.09%) | |
| Age | 18-30 | 891 (8.91%) | 447 (9.91%) | 0.1 |
| | 30-40 | 1454(14.54%) | 625 (13.86%) | |
| | 40-50 | 1900(19.01%) | 892 (19.78%) | |
| | 50-60 | 2422(24.23%) | 1026 (22.75%) | |
| | 60-70 | 1943(19.44%) | 865 (19.18%) | |
| | >70 | 1387(13.87%) | 655 (14.52%) | |
| Occupation | Other | 3765 (37.67%) | 1424 (31.57%) | <.0001 |
| | Retired | 2336 (23.37%) | 1052 (23.33%) | |
| | Non-sanitary | 2238 (22.39%) | 1281 (28.40%) | |
| | Sanitary | 1299 (13.00%) | 547 (12.13%) | |
| | Student of healthcare disciplines | 230 (2.30%) | 149 (3.30%) | |
| | Student of non-healthcare disciplines | 128 (1.28%) | 57 (1.26%) | |
| Family members | 1 | 1119 (11.19%) | 519 (11.51%) | 0.0401 |
| | 2 | 2973 (29.74%) | 1291 (28.63%) | |
| | 3 | 2459 (24.60%) | 1165 (25.83%) | |
| | 4 | 2567 (25.68%) | 1195 (26.50%) | |
| | ≥ 5 | 879 (8.79%) | 340 (7.54%) | |
| Type of pharmacy | Rural | 3892 (39.58%) | 1606 (36.89%) | 0.0079 |
| | Urban | 5941 (60.42%) | 2748 (63.11%) | |
| Geographical area | North | 6155 (62.60%) | 2613 (60.02%) | <.0001 |
| | Center | 1239 (12.6%) | 512 (11.76%) | |
| | South | 2439 (24.8%) | 1229 (28.22%) | |
| When was the last time you took an antibiotic? | In the last month | 1501 (15.02%) | 673 (14.92%) | 0.6767 |
| | I don’t know | 907 (9.07%) | 438 (9.71%) | |
| | More than a year ago | 4684 (46.86%) | 2108 (46.74%) | |
| | More than a month ago | 2904 (29.05%) | 1291 (28.63%) | |
| Have you ever taken antibiotics without a medical doctor’s prescription? | No | 7620 (76.23%) | 3447 (76.43%) | <.0001 |
| | No, but I would | 367 (3.67%) | 212 (4.70%) | |
| | I don’t know | 143 (1.43%) | 105 (2.33%) | |
| | Yes | 1866 (18.67%) | 746 (16.54%) | |
| When you are prescribed an antibiotic, does the pharmacist provide you with instructions? | No | 795 (7.95%) | 483 (10.69%) | <.0001 |
| | Not always | 1357 (13.58%) | 764 (16.91%) | |
| | Yes | 7844 (78.47%) | 3270 (72.39%) | |
| When you are prescribed an antibiotic, does your medical doctor give you any instructions? | No | 668 (6.68%) | 347 (7.69%) | 0.0005 |
| | Not always | 1416 (14.17%) | 724 (16.05%) | |
| | Yes | 7912 (79.15%) | 3439 (76.25%) | |
| Do you have a pet? | No | 5019 (56.86%) | 2396 (53.13%) | 0.012 |
| | Yes | 4850 (49.14%) | 2114 (46.87%) | |

| | | | | |
|---|---|---|---|---|
| Have you ever purchased antibiotics without a vet's prescription? | No | 5938 (60.2%) | 2262 (50.69%) | <.0001 |
| | I don't have one | 3520 (35.69%) | 1996 (44.73%) | |
| | Yes | 406 (4.12%) | 204 (4.57%) | |
| Have you ever advised relatives or friends to use an antibiotic? | No | 7352 (75.06%) | 3468 (76.90%) | 0.0165 |
| | Yes | 2443 (24.94%) | 1042 (23.10%) | |
| Have you ever been recommended antibiotics by relatives or friends? | No | 5675 (57.64%) | 2580 (57.21%) | 0.605 |
| | Yes | 4170 (42.36%) | 1930 (42.79%) | |
| Do you keep packages of antibiotics at home? including unfinished packages. | No | 4353 (44.0%) | 2127 (47.16%) | 0.0004 |
| | Yes | 5541 (56.0%) | 2383 (52.84%) | |
| When do you stop taking the antibiotic once you have started treatment? | Sometimes when I feel better, sometimes when I have followed the medical doctor's instructions | 724 (7.24%) | 378 (8.38%) | 0.0069 |
| | I don't know | 227 (2.27%) | 132 (2.93%) | |
| | When I have taken the medicine the number of times indicated by the medical doctor | 8434 (84.37%) | 3743 (82.99%) | |
| | When I feel better | 611 (6.11%) | 257 (5.70%) | |
| Indicate for which diseases antibiotics are always recommended | HIV/AIDS | 672 (4.00%) | 251 (3.00%) | <.0001 (total) |
| | Cystitis | 5687 (35.9%) | 2799 (36.0%) | |
| | Cold | 845 (5.00%) | 455 (6.00%) | |
| | Flu | 3478 (21.0%) | 1458 (19.0%) | |
| | Skin infection | 2604 (16.0%) | 1507 (19.0%) | |
| | Herpes | 759 (5.00%) | 306 (4.00%) | |
| | Dry cough | 1103 (7.00%) | 556 (7.00%) | |
| | SARS-COV-2 | 1154 (7.00%) | 493 (6.00%) | |
| Would you use antibiotics for toothache? | Never | 884 (8.84%) | 318 (7.05%) | <.0001 |
| | I don't know | 1077 (10.77%) | 447 (9.91%) | |
| | Always | 577 (5.77%) | 216 (4.79%) | |
| | Only in special cases (e.g. abscess) | 7458 (74.61%) | 3529 (78.25%) | |
| Do you think that in Italy the use of antibiotics in agriculture and breeding of animals intended for food production is high? | No | 642 (6.42%) | 237 (5.25%) | <.0001 |
| | I don't know | 3401 (34.02%) | 1353 (30.0%) | |
| | Yes | 5953 (59.55%) | 2747 (60.91%) | |
| Have you ever heard of antibiotic resistance? | No | | 1233 (27.34%) | 0.0769 |
| | I don't know | | 530 (11.75%) | |
| | Yes | 6244 (62.46%) | 2747 (60.91%) | |
| What does antibiotic resistance mean? | Consists of changing antibiotics to ensure greater effectiveness against resistant bacteria | 492 (4.92%) | 164 (3.64%) | 0.1577 |
| | Consists of the phenomenon whereby our body becomes resistant to a routinely used antibiotic | 2656 (26.57%) | 1106 (24.52%) | |
| | Consists of the ability of a bacterium to resist the action of an antibiotic drug, often acquired following the incorrect and excessive use of these drugs | 4409 (44.11%) | 2043 (45.3%) | |
| | I don't know | 2439 (24.4%) | 1197 (25.54%) | |



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|---|---|---|---|---|
| Are you at risk of developing antibiotic resistance if you take antibiotics as directed by your medical doctor? | No | 5043 (50.45%) | 2323 (51.51%) | 0.4275 |
| | I don't know | 3234 (32.35%) | 1442 (31.97%) | |
| | Yes | 1719 (17.2%) | 745 (16.52%) | |
| Does the resistance phenomenon only affect people who take antibiotics? | No | 6255 (65.15%) | 3016 (69.33%) | <.0001 |
| | Yes | 3346 (33.85%) | 1334 (30.67%) | |

Furthermore, those respondents who were able to define correctly the term AMR, were also more likely to adhere to the prescribed therapy (89.66% Phase 1A, 88.3% Phase 1B) whereas those who did not know the term were less likely to do so (80.2% Phase 1A, 78,6% Phase 1B).

Many respondents (64.15% Phase 1A, 69.33% Phase 1B) are aware of the fact that AMR is not just a phenomenon that affects people who take antibiotics. This is more frequent among those who know the correct meaning of AMR (70.38% Phase 1A, 75.34% Phase 1B).

**Phase 2**

The number of pharmacies participating in Phase 2 of the project was 218, most of these were located in urban areas (60.42%), and in the North of Italy (63.2%). The number of users recruited for the survey was 1,914; they were mostly female (62.07%), and from the North of Italy (59.27%). The most representative age group was that between 0 -10 years old, making up 27.22% of the respondents. Other socio-demographic variables are reported in Table 2. 45.09% of respondents tested positive to the GAS rapid test. The greatest prevalence was recorded in the regions of Central Italy (48.54% of rapid tests positive), and in male respondents (46.49% of rapid tests positive), although the difference is not statistically significant (p=0.27 and p= 0.31 respectively). The 0-10 years old group had the highest rates of GAS infections with a percentage of positive cases of 59.31%. This percentage rises to 60.74% in the age group between 6-10 years old. Positive cases in ages over 10 years old are, instead, fewer, and, on average, make up 39.77% of cases. In particular, children (0-10 years old) have a higher risk of contracting GAS infections compared with adults (41-65 years old) (OR=2.46, 1.93-3.14 95% CI) and the elderly (age >65) (OR=2.00, 1.35-2.97 95% CI).

In general (see Table 3), the percentage of positive cases increases among those subjects who declared a symptomology linked to the throat such as sore throat, irritated throat, odynophagia, or burning throat (OR=1.39, 1.15 – 1.69 95% CI). The correlation is even more significant for those users who, as well as a symptom in the throat region, declared the presence of tonsil stones (OR=3.28, 1.46-7,36 95% CI).

Regarding Tables 4 and Table 5, the relationship between throat symptoms and a positive rapid test is clear for the various age groups and is particularly significant for elderly subjects. Indeed, older subjects (>65 years old) with throat symptoms tested positive in 82.22% of cases, adults (41-65 years old) in 75.37% of cases, young people (11-40 years old) in 72.55% of cases, and children (0-10 years old) in 64.08% of cases (p=0.0072).

## DISCUSSION

The project "Antimicrobicoresistenza: è tempo di agire" (Antimicrobial resistance: it's time to act) enabled us to conduct a nation-wide investigation into the issues connected with AMR in the population using community pharmacies in Italy. The data gathered in Phase 1 of the project were collected by means of a self-administered questionnaire (Phase 1A), or interviews conducted by community pharmacists (Phase 1B). The compilation time for the questionnaire in the two phases was to all intents identical, at an average of 8 minutes approximately. However, the number of subjects interviewed in Phase 1B was about half that of Phase 1A. This is probably due to the fact that in Phase 1B the pharmacist was obliged to take time away for his/her other duties to compile the questionnaire with the interviewee. As regards the results obtained in the two phases -1A and 1B-, and the compilation times, which are practically identical, it can be affirmed that for a study such as this, the use of a self-administer questionnaire can be deemed a valid means of gathering data. Certainly, this cannot be extended to all studies to be conducted at community pharmacies regarding issues or pathologies, but this method must be evaluated on a case-by-case basis. Regardless, therefore, of the mode of administration, the data collected by the questionnaire enable us to firstly highlight the need for health care professionals to provide education and to focus the attention of the Italian population on the issue of AMR. This is evident if we consider the fact that, in response to the questions "Have you ever taken antibiotics without a prescription?", the percentage of negative answers was not 100%, but hovered around 75%; a figure that is, while positive, not comforting.

The same may be said for the respondents' answers regarding the instructions given to them by medical doctors and pharmacists concerning the correct use of antibiotics they had been prescribed on previous occasions: according to the data, one user out of four had not been routinely provided with adequate explanations about the correct management of the therapy. Moreover, too many users still declare that they advise or receive advice from family and friends regarding treatment with antibiotics: it is almost certain that this behaviour leads

**TABLE 2.** Phase 2 results

| Variable | Options | N (%) Phase 2 |
|---|---|---|
| Sex | Female | 1188 (62.07%) |
| | Male | 712 (37.20%) |
| | Not specified | 14 (0.73%) |
| Age | 0-10 | 521 (27.22%) |
| | Nov-20 | 228 (11.91%) |
| | 21-30 | 187 (9.77%) |
| | 31-40 | 322 (16,82%) |
| | 41-50 | 303 (15.83%) |
| | 51-60 | 185 (9.67%) |
| | 61-70 | 108 (5.64%) |
| | 71-80 | 42 (2.19%) |
| | >80 | 18 (0.94%) |
| Occupation | Other | 853 (44.57%) |
| | Retired | 115 (6.01%) |
| | Non-health | 448 (23.41%) |
| | Health | 175 (9.14%) |
| | Student non-health faculty | 301 (15.73%) |
| | Student health faculty | 22 (1.15%) |
| Number of family members | 1 | 97 (5.07%) |
| | 2 | 245 (12.80%) |
| | 3 | 552 (28.84%) |
| | 4 | 773 (40.39%) |
| | ≥5 | 247 (12.90%) |
| Type of Pharmacy | Rural | 550 (33.64%) |
| | Urban | 1085 (66,36%) |
| Area | North | 969 (59.27%) |
| | Centre | 309 (18.9%) |
| | South | 357 (21.83%) |
| Do you have a cough? | Yes | 44 (2.30%) |
| | No | 1870 (97.70%) |
| Do you have rhinitis (runny nose)? | Yes | 44 (2.30%) |
| | No | 1870 (97.70%) |
| Result of rapid test | Negative | 1051 (54.91%) |
| | Positive | 863 (45.09%) |

**TABLE 3.** OR calculated for risk of positive test

| Variable | OR | 95% Wald Confidence Limits | |
|---|---|---|---|
| Symptoms in throat | 1.393 | 1.149 | 1.689 |
| Symptoms in throat and puss | 3.285 | 1.465 | 7.364 |
| Symptoms in throat and temperature | 1.709 | 1.304 | 2.241 |
| Puss and temperature | 11.028 | 0.419 | 290.12 |
| Symptoms in throat, puss and temperature | 8.571 | 0.279 | 263.402 |
| Cough | 0.728 | 0.347 | 1.526 |
| Rhinitis | 1.039 | 0.508 | 2.126 |
| Cough and Rhinitis | 0.995 | 0.218 | 4.55 |
| Female vs Male | 0.921 | 0.764 | 1.11 |
| Rural Pharmacy vs Urban Pharmacy | 0.823 | 0.669 | 1.012 |
| Centre vs north | 1.173 | 0.907 | 1.516 |
| Centre vs south | 1.085 | 0.8 | 1.472 |
| North vs South | 0.925 | 0.725 | 1.181 |
| Age 0-10 vs 11-40 | 2.047 | 1.625 | 2.579 |
| Age 0-10 vs 41-65 | 2.466 | 1.933 | 3.146 |
| Age 0-10 vs >65 | 2.001 | 1.349 | 2.969 |

**TABLE 4.** Relationship between throat symptoms and positive test

| Age | N subjects | % of Total | N positive subjects | % of positive subjects | Subjects with throat symptoms | % of Total | N positive subjects | % of positive subjects | p- value |
|---|---|---|---|---|---|---|---|---|---|
| **Age** | | | | | | | | | |
| 0-10 | 521 | 27.22 | 309 | 59,31 | 330 | 63,34 | 198 | 60,00 | <0.0001 |
| Nov-40 | 737 | 38.51 | 306 | 41.52 | 504 | 68,39 | 222 | 44.05 | |
| 41-65 | 547 | 28.58 | 203 | 37.11 | 376 | 68.74 | 153 | 40.69 | |
| >65 | 109 | 5.69 | 45 | 41.28 | 66 | 60.55 | 37 | 56.06 | |
| **Sex** | | | | | | | | | |
| Male | 712 | 37,20 | 428 | 60,11 | 454 | 35.58 | 226 | 49.78 | 0.1932 |
| Female | 1188 | 62,07 | 774 | 65,15 | 816 | 63.95 | 383 | 46.94 | |
| ND | 14 | 0.73 | 6 | 42,86 | 6 | 0.47 | 1 | 16.67 | |
| **Area** | | | | | | | | | |
| Urban | 1085 | 66,36 | 514 | 47,37 | 356 | 32.63 | 167 | 46.91 | 0.5775 |
| Rural | 550 | 33,64 | 234 | 42,55 | 735 | 67.37 | 358 | 48.71 | |
| **Geographical area** | | | | | | | | | |
| North | 969 | 59.27 | 432 | 44,58 | 660 | 60.49 | 295 | 44.7 | 0.012 |
| Centre | 309 | 18.9 | 150 | 48,54 | 217 | 19.89 | 121 | 55.76 | |
| South | 357 | 21.83 | 166 | 46,50 | 214 | 19.62 | 109 | 50.93 | |

**Table 5.** Relationship between throat symptoms and positive test by age group

| Throat symptoms | | Age | | | | | |
|---|---|---|---|---|---|---|---|
| | | **0-10** | **11-40** | **41-65** | **>65** | **Total** | **p-value** |
| **No** | subjects in the age group | 111 | 84 | 50 | 8 | 253 | 0.0072 |
| | % of total subjects | 12,86 % | 9,73 % | 5,79 % | 0,93 % | 29,32% | |
| | % of total negative subjects | 43,87 | 33,2 | 19,76 | 3,16 | 100% | |
| | % of total subjects in the age group | 35,92 | 27,45 | 24,63 | 17,78 % | | |
| **Yes** | N | 198 | 222 | 153 | 37 | 610 | |
| | % of total subjects | 22,94 | 25,72 | 17,73 | 4,29 | 70,68 % | |
| | % of total positive subjects | 32,46 | 36,39 | 25,08 | 6,07 | 100% | |
| | % of total subjects in the age group | 64,08 | 72,55 | 75,37 | 82,22 % | | |
| **Total** | subjects in the age group | 309 | 306 | 203 | 45 | 863 | |
| | % of total subjects | 35,81 % | 35,46 % | 23,52 % | 5,21% | 100% | |

to an incorrect use of antibiotics, and this should be a point for particular attention especially given that about half of the respondents affirmed that they conserve antibiotics at home, and hence might decide to self-medicate rather than consult their medical doctor or a pharmacist. Furthermore, having a stock of unused antibiotics at home is concerning, as this may be a signal to having interrupted a previous therapy pre-emptively. It is especially significant that two-thirds of the respondents are unable to identify correctly the pathologies that require treatment with antibiotics among those listed in the questionnaire: this corroborates the concern regarding the potential risks due to self-medication with antibiotics.

As for the issue of AMR, more than half of respondents declared that they were aware of the problem, but in terms of its meaning, less than half were able to identify it correctly: this is particularly significant given that the correct knowledge and understanding of the phenomenon is positively correlated with respondents' declarations of greater adherence to therapy.

Regarding Phase 2, given that the subjects were enrolled only if they declared symptoms consistent with a GAS infection, it is possible to affirm that the presence of such symptoms was not at all predictive of a positive result to the rapid test with the exception of the 0-10-year-old age group. This is in fact the only age group in which the percentage of positive cases was greater than 50% (59.31%). Considering, however, more specifically those who declared a set of symptoms affecting the throat, the likelihood that a subject has a positive test rises significantly with age. This point should certainly be

considered by community pharmacists when evaluating which subjects actually require a GAS test, i.e., subjects of school-age, regardless of the symptoms, and those over 65 years old displaying throat related symptoms.

## CONCLUSIONS

The data gathered in this study revealed the relatively low awareness of AMR, and poor knowledge of the correct use of antibiotics among the surveyed population. In light of these results, and the fact that community pharmacies are among the health services most easily accessible to the general public, their active involvement in any campaign to raise awareness and educate the population on the topic of AMR should be considered as an important resource to be exploited. Naturally, in order to maximise the benefits of the measures taken by community pharmacies in the fight against AMR, a coordinated campaign at a national level is essential: this would ensure that the correct information reaches users in a standardised manner. In addition, considering the data gathered and the correlation detected between the symptoms declared by interviewees, their age, and the results of the rapid tests for GAS, the possibility, as foreseen by the current legislation in Italy[36], that the pharmacist may offer GAS-infection testing to subjects can be considered important: identifying positive cases in a more targeted manner and referring them to a medical doctor with a confirmed result of the GAS rapid test would certainly help to facilitate the prescription of the correct antibiotic therapy and limit the use of antimicrobials for which there is already a high likelihood of resistance.

## LIMITATIONS OF THE STUDY

The performed study involved customers from the population belonging to community pharmacies rather than the general population.

## ETHICAL STATEMENT

The study "Antimicrobicoresistenza: è tempo di agire" (Antimicrobial resistance: it's time to act) was approved by the bioethics committee of the University of Turin on 4 December 2023, protocol no. 0634503.

The subjects participated in the study (Phase 1 or Phase 2) on a voluntary basis, and they were orally informed of the characteristics and the purpose of the study. The questionnaires were anonymous. Personal data were not collected and there is no way to trace back to a specific respondent. The subjects expressed their consent to participate in the study orally. No written consent was produced to ensure anonymity for the participants. In Phase 2, in case of minor subjects, consent was expressed by the parents.

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## AUTHOR CONTRIBUTIONS

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## CONFLICTS OF INTEREST

The authors report no conflicts of interest in this work

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